

# Fiatlight: Brighten the Journey from Idea to Creation

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Fiatlight is a user-friendly tool that helps you transform your ideas into fully functional applications, using minimal code, or a drag-and-drop interface. The delay between an idea and a full application may be reduced to a few minutes.

*For technical readers:*

*Fiatlight is a versatile Python framework that enables rapid development and visualization of applications by chaining functions into interactive graphs. It features automatic GUI generation for diverse data types, including primitive type, images, audio (...), and provides powerful debugging tools. It generates full applications that can save their state and presentation options.*

The name "Fiatlight" is inspired by "Fiat Lux", i.e. "Let there be light".

# Create an GUI for any function

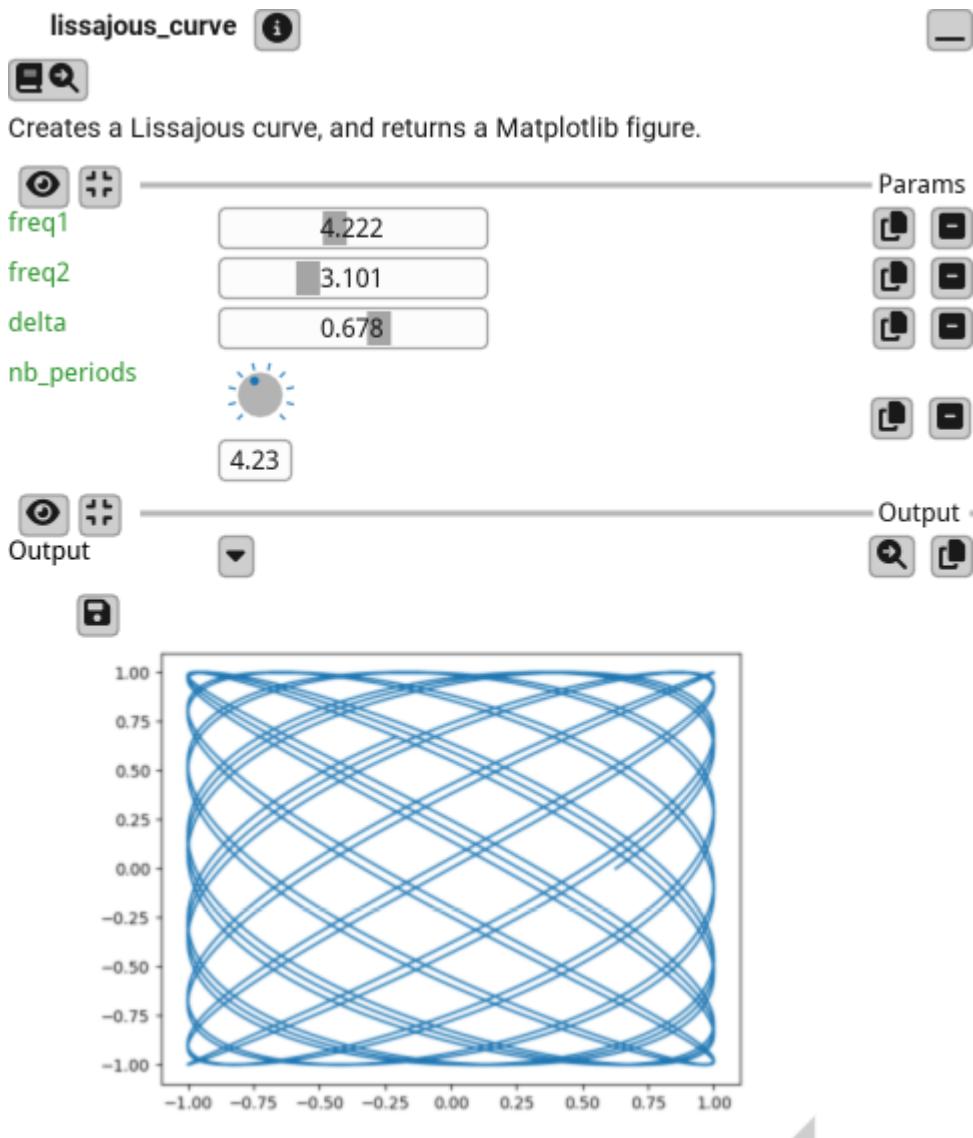
Simply call `fl.run` with a function or a list of functions, and Fiatlight will automatically generate a GUI for them.

```
# Part 1: Standard Python code (no user interface)
# -----
import numpy as np
from matplotlib.figure import Figure
import matplotlib.pyplot as plt

def lissajous_curve(freq1: float = 5.0, freq2: float = 4.0, delta: float = np.pi / 6.0):
    """Creates a Lissajous curve, and returns a Matplotlib figure."""
    t = np.linspace(0, 2 * np.pi * nb_periods, 10_000)
    x = np.sin(freq1 * t + delta)
    y = np.sin(freq2 * t)
    fig, ax = plt.subplots()
    ax.plot(x, y)
    return fig

# Part 2: Add a GUI to the code in a few seconds
# -----
import fiatlight as fl

# Options for widgets
fl.add_fiat_attributes(
    lissajous_curve,
    freq1_range=(0, 10), freq2_range=(0, 10), delta_range=(-np.pi, np.pi),
    nb_periods_range=(0.1, 10), nb_periods_edit_type="knob",
)
# Run the function interactively
fl.run(lissajous_curve, app_name="Interactive Lissajou Curve")
```



See the application in action in the video below

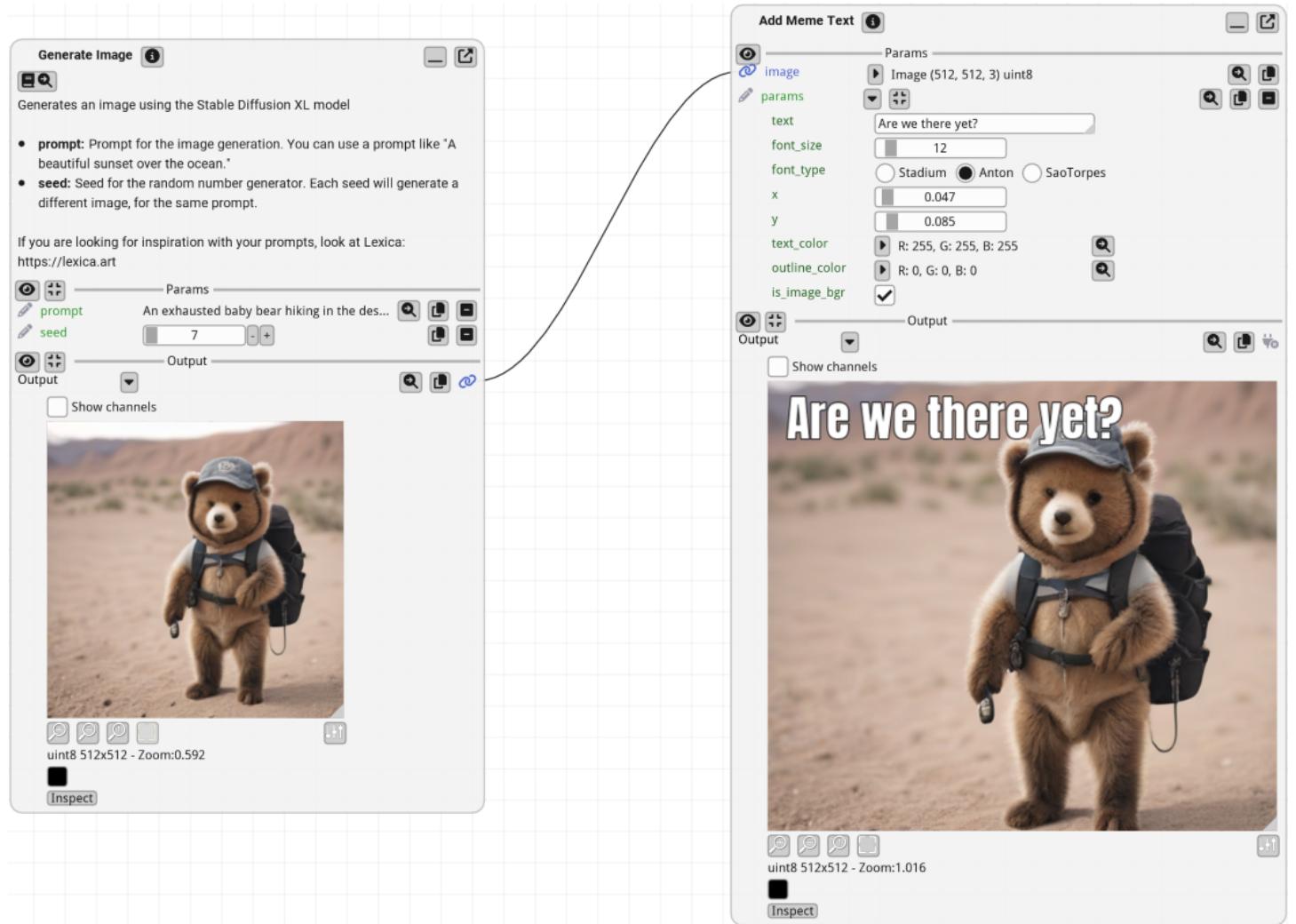
## From Idea to App in 3 minutes

Create a full application in just 4 lines of Python by chaining pure Python functions into an interactive graph. This graph visually displays each function's inputs and outputs, allowing for manual input adjustments.

Example: The application below is a meme generator. It is a simple composition of an AI image generator, and a function that adds text onto an image

```
import fiatlight as fl
from fiatlight.fiat_kits.fiat_ai import invoke_sdxl_turbo
from fiatlight.fiat_kits.fiat_image.add_meme_text import add_meme_text

# Run the composition to create a simple app
fl.run([invoke_sdxl_turbo, add_meme_text], app_name="Old school meme generator")
```



This can be used as a full application:

- All inputs are saved: prompt, and meme text, font, color, position of the text
- All preferences are saved: window size, position, and layout of the nodes
- The user can save and load different state of the application (i.e. different memes)

For technical readers: [`invoke\_sdxl\_turbo`](#) provides a simple wrapper to SDXL, and [`add\_meme\_text`](#) is a Python function that adds colored text onto an image.

## Domain-specific Kits:

[`fiatlight.fiat\_kits`](#) is intended to provide a set of pre-built functions and widgets for various domains, such as:

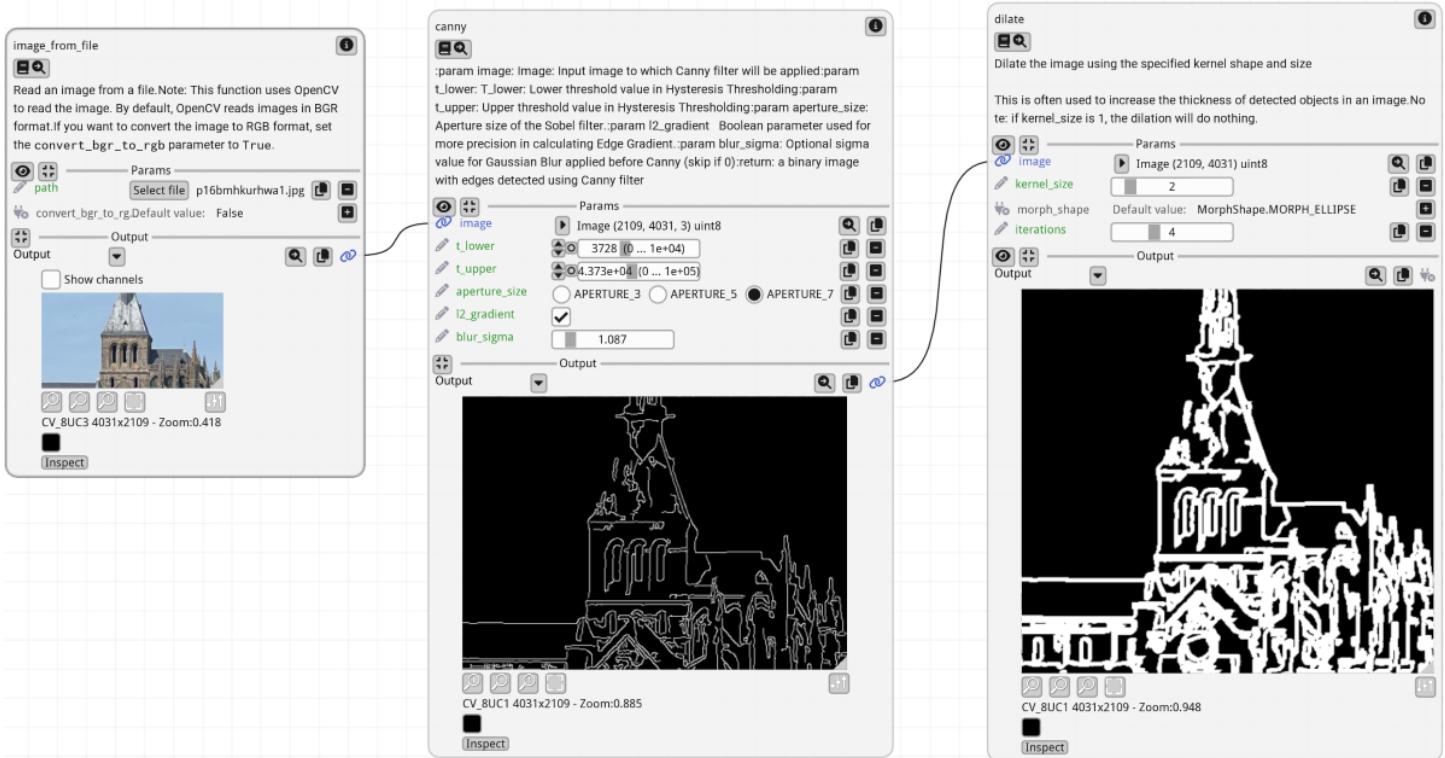
- **Image analysis:** Sophisticated image analysis and manipulation widgets. See [`fiat\_image`](#).
- **Data Visualization:** Display interactive data plots and charts for real-time data analysis, using Matplotlib or ImPlot. See [`fiat\_matplotlib`](#), and [`fiat\_implot`](#) (for ImPlot)
- **Data Exploration:** Provide widgets for exploring dataframes. See [`fiat\_dataframe`](#).
- **AI:** (Draft) Provide a widget for Prompt entry, and an interface to Stable Diffusion. See [`fiat\_ai`](#).

## Image analysis

The example below shows an image which undergoes a pipeline for a dilated edge extraction. The image viewer can pan & zoom the images in sync, and display the pixel values

```
import fiatlight as fl
from fiatlight.fiat_kits.fiat_image import image_from_file
from fiatlight.demos.images.opencv_wrappers import canny, dilate

fl.run([image_from_file, canny, dilate], app_name="demo_computer_vision")
```

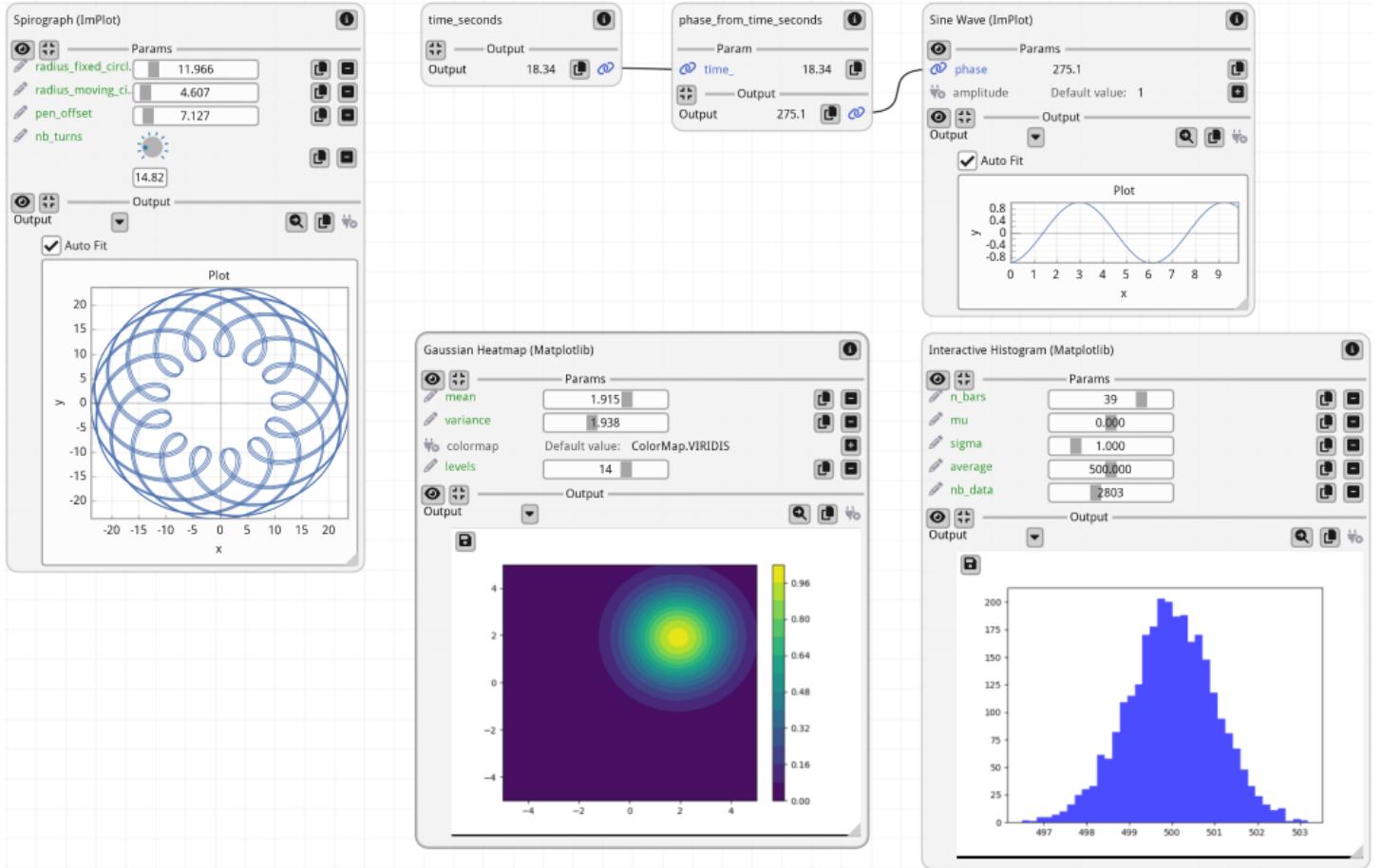


For technical readers: [image\\_from\\_file](#) is a function that reads an image from a file, [canny](#) applies the Canny edge detection algorithm, and [dilate](#) dilates the edges.

## Data visualization with Matplotlib and ImPlot

In the example below, we display figures using [ImPlot](#) (left) and [Matplotlib](#) (right). Each figure provides user-settable parameters (in a given range, with customizable widgets). The sine wave function is updated in real time.

```
from fiatlight.demos.plots import demo_mix_implot_matplotlib
demo_mix_implot_matplotlib.main()
```



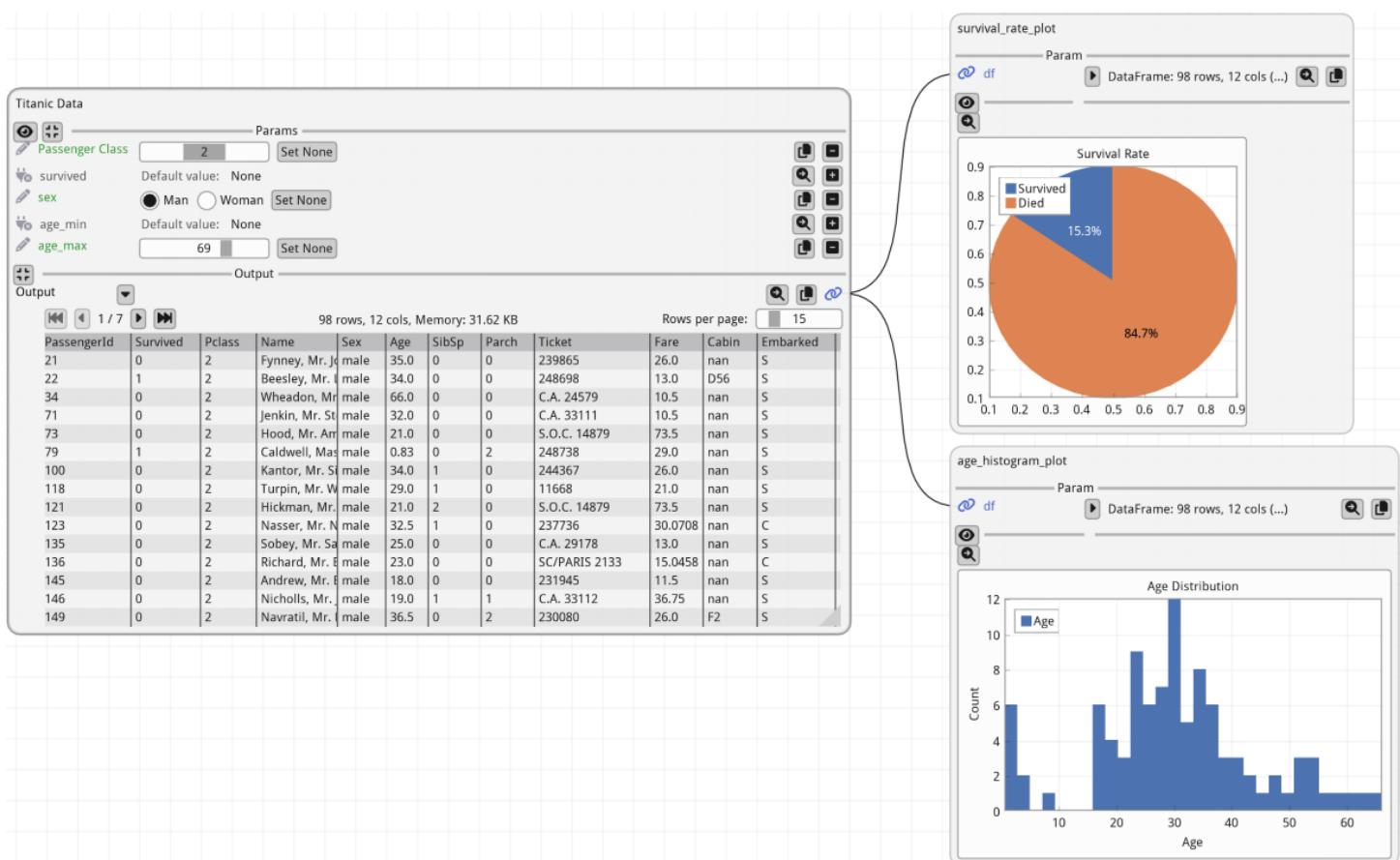
For technical readers:

- when a function returns a `matplotlib.figure.Figure`, its output will be displayed as a plot. See `demo_matplotlib.py` [source code](#).\*
- when a function returns a `fiat_implot.FloatMatrix_Dim1` or `fiat_implot.FloatMatrix_Dim2` (which are aliases for `np.ndarray`), its output will be displayed as a plot, using `ImPlot`. See `demo_implot` [source code](#).
- `ImPlot` is a plotting library for Dear ImGui. It is often faster than Matplotlib, and can be used in real-time applications. For a complete demo of `ImPlot`, click here: [ImPlot complete demo](#)\*

## Data Exploration

In the example below, we display a data frame from the famous titanic example with filtering.

```
from fiatlight.fiat_kits.fiat_dataframe import dataframe_with_gui_demo_titanic
dataframe_with_gui_demo_titanic.main()
```

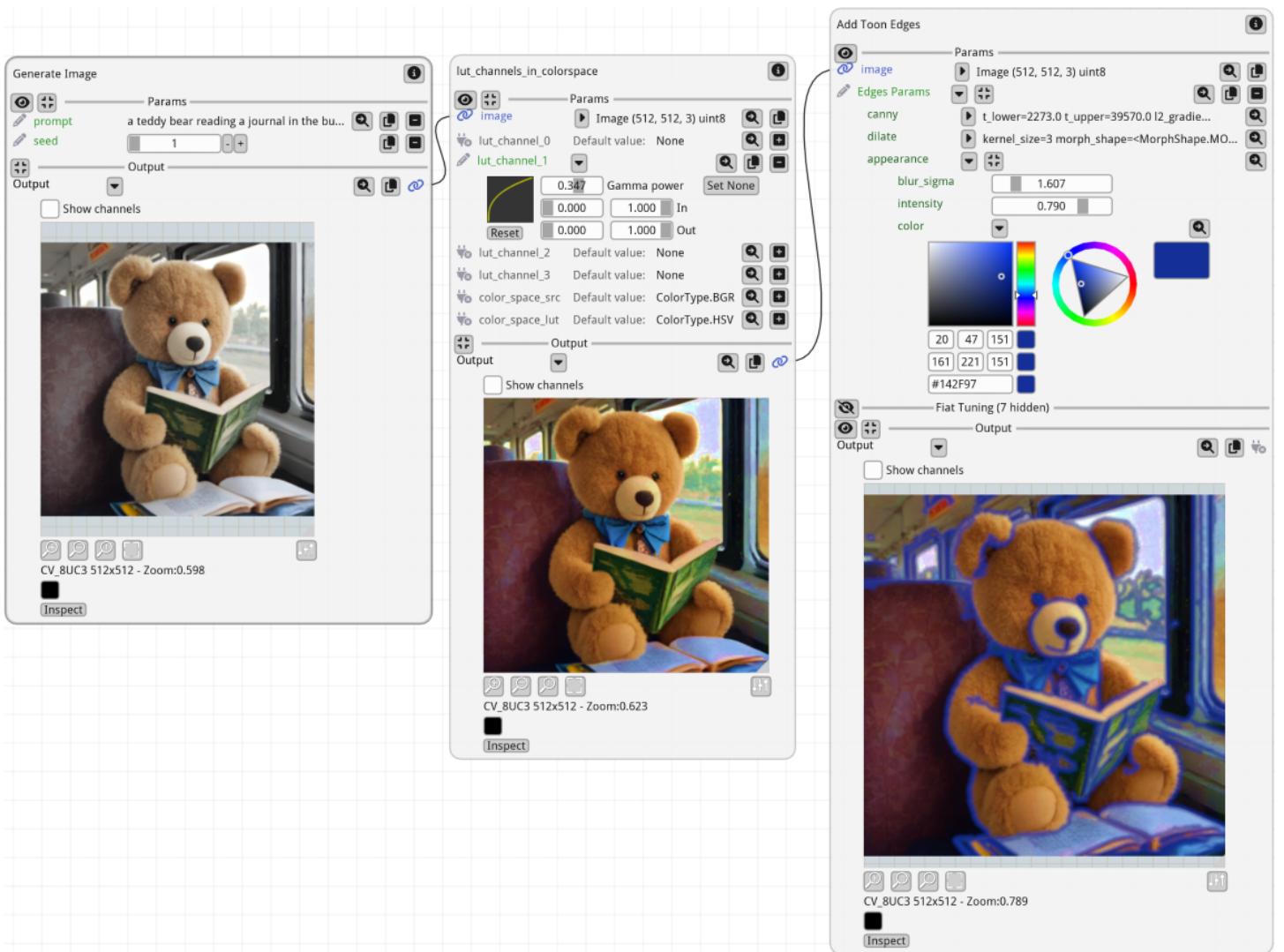


## AI - Image generation

Example: the application below generates images using a stable diffusion model, and enables to add effects to it (color transformation, add colored edges).

```
import fiatlight as fl
from fiatlight.fiat_kits.fiat_ai import invoke_sdxl_turbo
from fiatlight.fiat_kits.fiat_image import lut_channels_in_colorspace
from fiatlight.demos.images.toon_edges import add_toon_edges

fl.run([invoke_sdxl_turbo, lut_channels_in_colorspace, add_toon_edges], app_name="S")
```

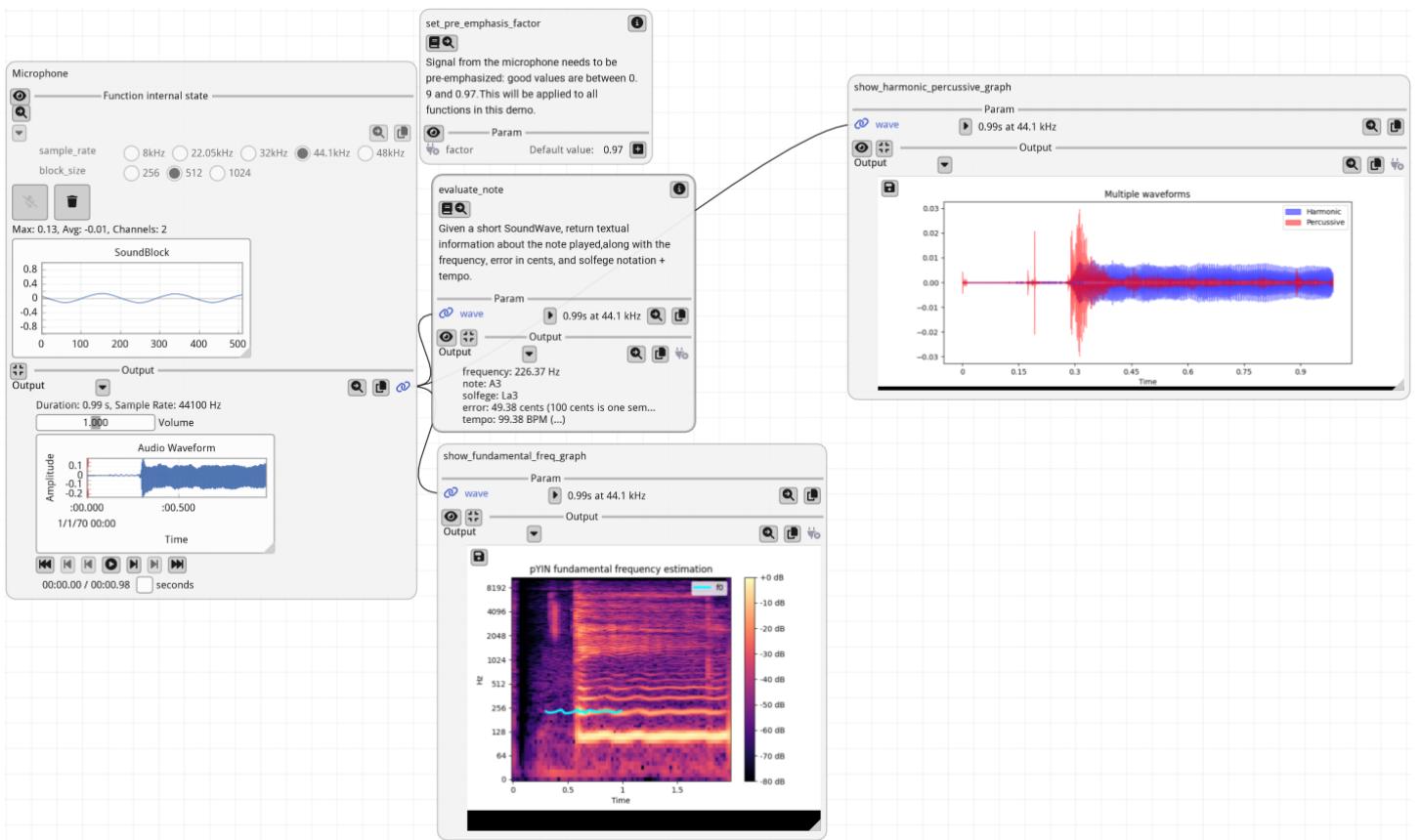


For technical readers: [invoke\\_sdxl\\_turbo](#) uses HuggingFace's diffuser library to invoke stable diffusion. See its [source code](#)

## Audio processing (experimental)

Example: the application below is a demo where you can sing into the microphone and see information about the note you're singing + advanced graphs using librosa.

```
from fiatlight.fiat_kits.experimental.fiat_audio_simple.demos import demo_audio_pro
demo_audio_processing.main()
```



For technical readers: See [demo\\_audio\\_processing source code](#)

## Visualize, Understand, Innovate

### Visualize the Pipeline flow

Example: the application below looks for the most frequent words in a given text file (here with the text from "Hamlet"), by applying a pipeline of transformations. It is possible to inspect the input and outputs of each function.

```
from fiatlight.demos.string import demo_word_count
demo_word_count.main()
```



For technical readers: `demo_word_count` will simply chain the following string functions:

`text_from_file`, `str_lower`, `split_words`, `filter_out_short_words`, `sort_words`,  
`run_length_encode`, `sort_word_with_counts`. See its [source](#)

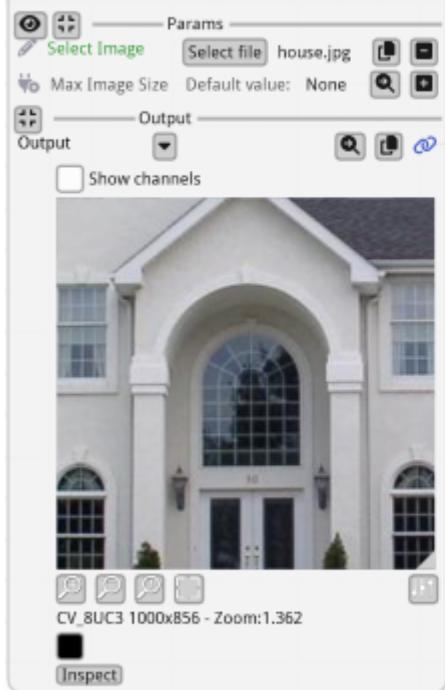
## Examine and understand function internals

flatlight provides you with powerful tools to visually debug the intermediate states of your function.

Example: the function `add_toon_edges` below is a complex function that adds a toon effect to an image. We can visualize the intermediate internal variables of the function (edges, dilated edges), even if they are not returned by the function.

```
import flatlight as fl
from flatlight.flat_kits.flat_image import ImageU8_GRAY, ImageU8_3, image_source
from flatlight.demos.images.toon_edges import add_toon_edges

fl.run([image_source, add_toon_edges], app_name="Toon Edges")
```



**Add Toon Edges**

**Params**

image

Edges Params

canny

- t\_lower
- t\_upper
- l2\_gradient
- blur\_sigma
- aperture\_size  APERTURE\_3  APERTURE\_5  APERTURE\_7

dilate  kernel\_size=3 morph\_shape=<MorphShape.MORPH\_RECT>

appearance  blur\_sigma=0.0 intensity=0.8 color=(23, 23, 23)

**Flat Tuning**

duration\_canny 0.002982  
duration\_dilate 0.0002911  
duration\_blur 2.146e-06  
duration\_merge 0.08707  
canny

CV\_8UC1 1000x856 - Zoom:0.930

[Inspect]

dilate

CV\_8UC1 1000x856 - Zoom:0.930

[Inspect]

image\_with\_edge\_<input type="checkbox"/>

Show channels

CV\_8UC3 1000x856 - Zoom:0.930

[Inspect]

**Output**

Show channels

For technical readers: the function `add_toon_edges` has an attribute `fiat_tuning` that contains the internal variables that will be displayed. See [demos/images/toon\\_edges.py](#).

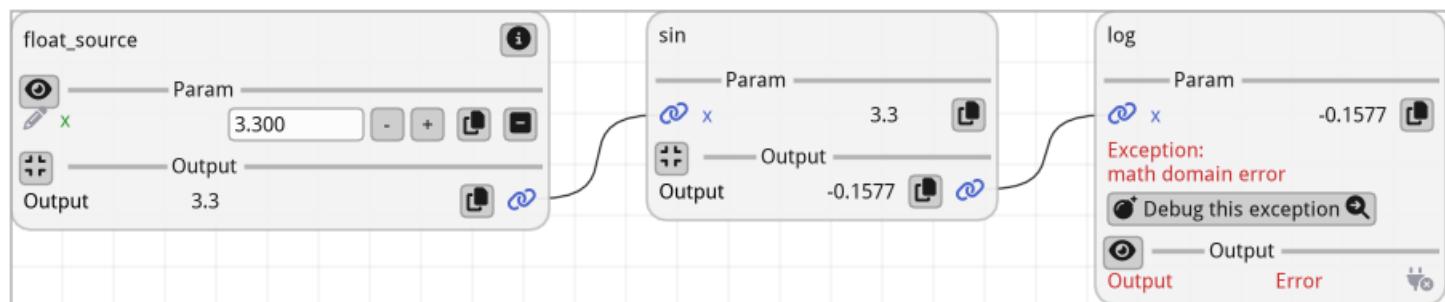
## Replay and debug function errors

Example: the following application raises an error. However, this error can be replayed, with **the exact same inputs** to facilitate the debugging

```
import fiatlight as fl
import math

def float_source(x: float) -> float:
    """A source where the user can specify an input value."""
    return x
def sin(x: float) -> float:
    return math.sin(x)
def log(x: float) -> float:
    return math.log(x)

fl.run([float_source, sin, log], app_name="Replay error")
```



For technical readers: the function `log` will raise an error when  $x$  is negative. Once you click on the "Debug this exception" button, you will be able to debug it:

```
30 def log(x: float) -> float: x: -0.00044499999771836145
31     """A function that computes the natural logarithm of its input.
32     Works only for positive inputs!
33     """
34
35     return math.log(x)
```

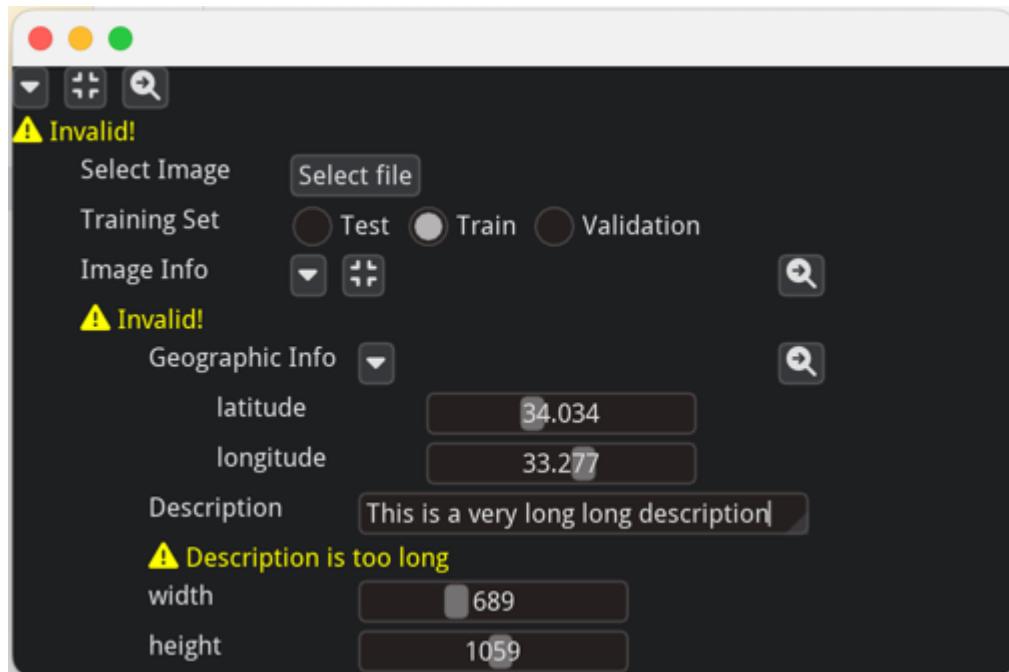
# Full-fledged Applications

Besides being extremely powerful to generate function graphs, Fiatlight's powerful GUI capabilities can also help you generate sophisticated classic applications.

## Sophisticated widgets and data validation

The application below, demonstrate how you can use Fiatlight GUI capabilities to edit complex data. The GUI definition was created automatically, from the data definition (including the validation rules, in yellow).

```
from fiatlight.demos.tutorials.pydantic_gui import demo_basemodel_app  
# demo_basemodel_app.main()
```



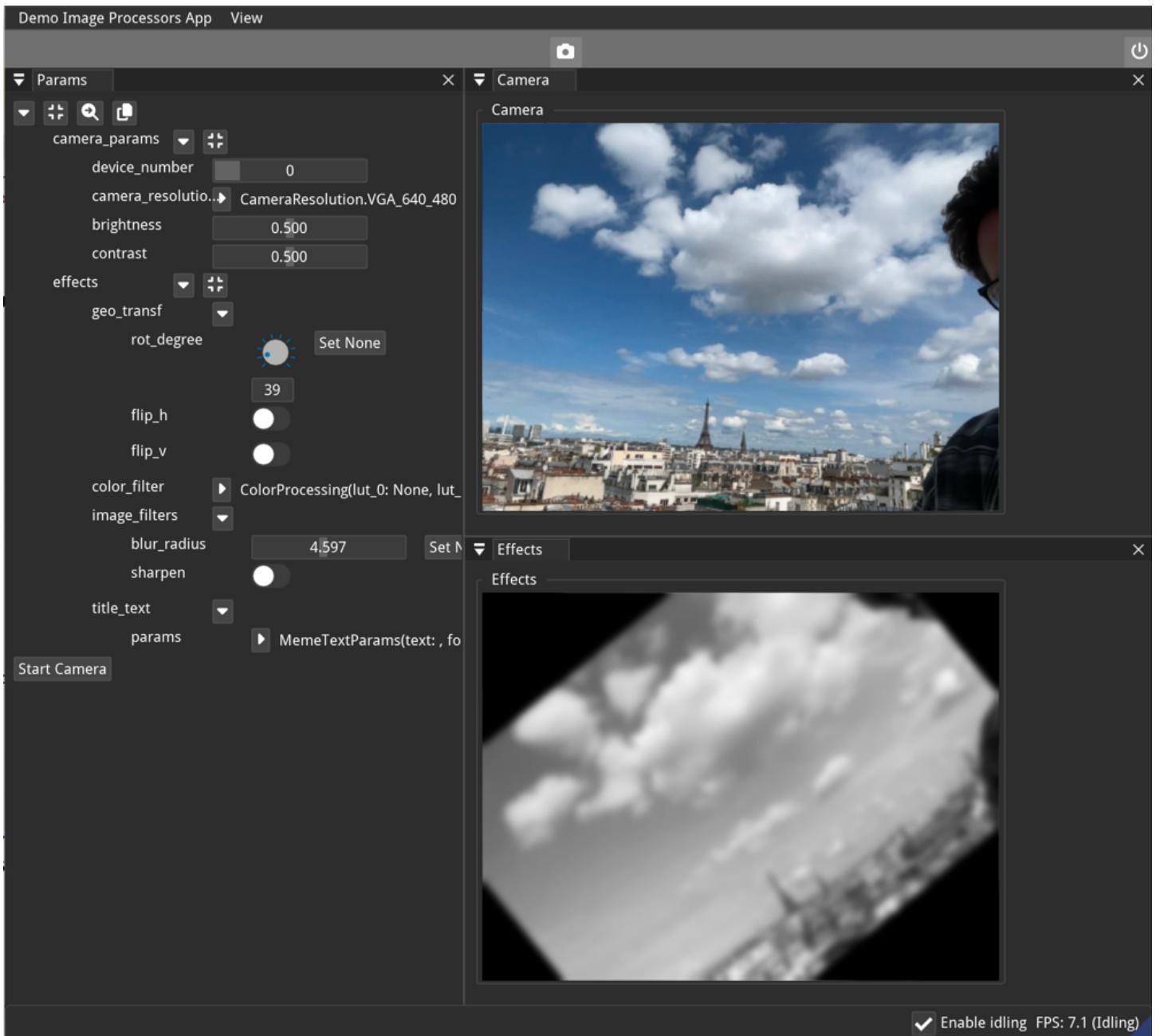
*For technical readers: See the [source code](#) for `demo_basemodel_app.py`. The GUI was created automatically, from a nested Pydantic model, with custom validator.*

# Applications with advanced GUI

The example below shows an application which:

- reuses the sophisticated GUI provided by Fiatlight in a standard application
- automatically, Save and reloads its state, and GUI presentation options
- provides dockable windows, and a top toolbar

```
from fiatlight.demos.full_fledged_app import demo_image_processors_app  
# demo_image_processors_app.main()
```



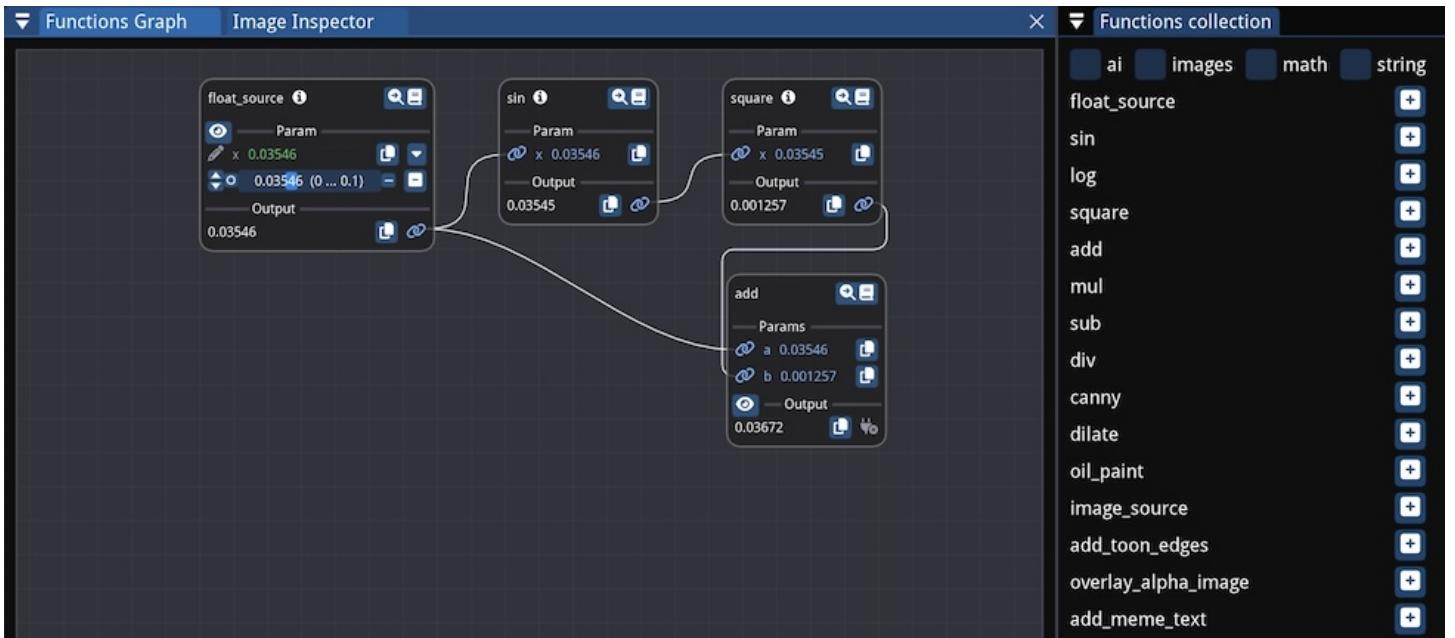
- For technical readers: See the [source code](#) for `demo_image_processors_app.py`\*.

## Custom Graph Creation

Create custom graphs with a drag-and-drop interface, similar to Scratch, enabling a visual approach to building workflows.

*Example: in the image below, its is possible to add and link function nodes:*

```
from fiatlight.demos.custom_graph import demo_custom_graph
# demo_custom_graph.main()
```



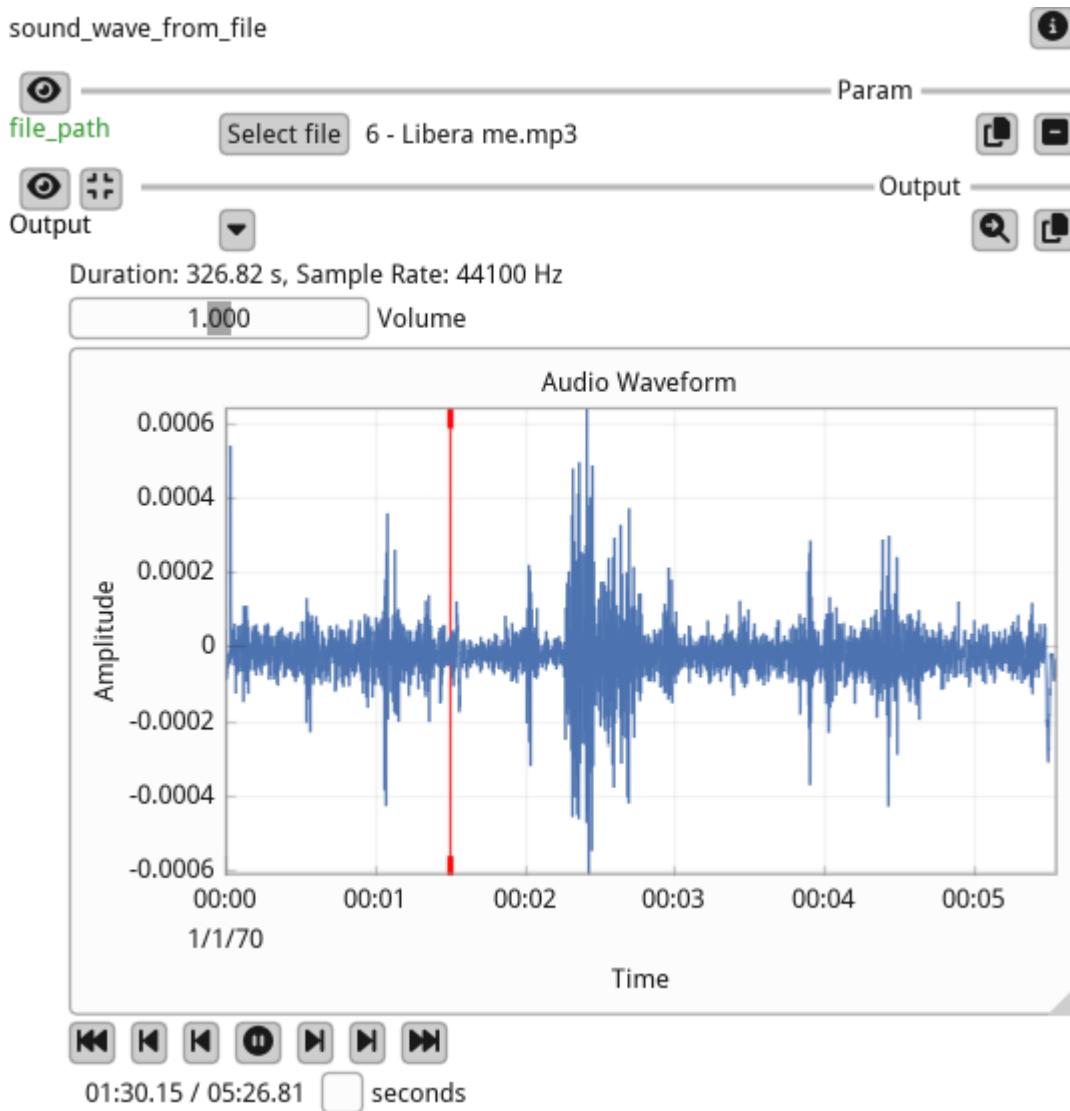
For technical readers: See the [source code](#) for `custom_graph.py`

## Custom Widgets

Define custom ranges for data types, create custom widgets, and leverage special function attributes like `async`, `live`, and `ranges` for enhanced functionality and performance.

Example: display and play a sound wave with a custom widget

```
import fiatlight as fl
from fiatlight.fiat_kits.experimental.fiat_audio_simple import sound_wave_from_file
fl.run(sound_wave_from_file, app_name="Sound Wave Player")
```



For technical readers: `sound_wave_from_file` is a function that returns a sound wave from a file, and the widget is a custom widget that displays the sound wave and allows you to play it. See its [source code](#)

## A sneak peek at the future: desktop Notebooks

The advanced GUI creation capabilities of Fiatlight might make it possible to consider providing an alternative renderer for Jupyter notebooks, using Fiatlight highly interactive widgets. They would run outside the browser, and may provide a more desktop-like experience for some notebooks.

Code Cell with a custom renderer (plot)

Run L:03 C:10

```

1 import numpy as np
2 t = np.linspace(0, 2*np.pi, 100)
3 np.sin(t)

```

Fiatlight is well-adapted for:

- **App Prototyping:** Quickly prototype and develop robust applications.
- **Fine-Tuning and Debugging:** Leverage Fiatlight as a powerful tool for fine-tuning your applications and shining light on all the intermediate states of your algorithms.
- **Education:** Teach programming and data analysis with interactive tools.
- **Data Exploration:** Engage in interactive exploration and visualization of complex datasets.
- **AI Development:** Build and visualize sophisticated AI models and algorithms.
- **App Development:** Since it is based on Dear ImGui, prototypes developed with fiatlight can serve as a basis for full-fledged applications. Those application may then also be translated to C++ with little effort, since the C++ and Python API for ImGui and Hello ImGui are very similar.

Fiatlight combines the strengths of several other tools and frameworks, while trying to provide a more integrated and flexible solution, making it suitable for both beginners and advanced users.

- [\*\*Scratch\*\*](#): For visual graph creation.
- [\*\*Jupyter\*\*](#): For interactive data exploration.
- [\*\*Unity Blueprints\*\*](#): For visual scripting and custom widgets.
- [\*\*Python Streamlit & Dash\*\*](#): For easy app creation with integrated GUI elements.
- [\*\*Ryven\*\*](#): For advanced graph creation.
- [\*\*Comfy UI\*\*](#): For AI workflow integration.
- [\*\*LEGO Mindstorms\*\*](#): For educational and creative applications.

Compared to the aforementioned software frameworks, Fiatlight distinguishes itself by:

## Pros

- its advanced introspection capabilities, which enable the automatic creation of a graphical interface
- its ability to visualize the intermediate states of a function
- its ability to replay errors
- its ability to automatically save and restore the state of an application, and to save and reload several states per application
- its speed and efficiency, thanks to the fact that the rendering is done in C++ with ImGui and OpenGL
- its use of the immediate mode GUI paradigm, which makes it easy to create very adaptive and responsive GUIs
- its ability to prepare the path to a full-fledged application, since any custom widgets and callbacks developed within Fiatlight can be reused in an application based on Dear ImGui (and/or Dear ImGui Bundle). Transitioning to C++ is also within reach, since the C++ and Python API for ImGui and Hello ImGui are very similar.

## Cons

- Fiatlight does work on Jupyter notebooks (this document is actually a Jupyter notebook). However, it requires a local computer (and will not work on Google Colab, for example). Solutions for this are being explored.

Note: detailed comparisons with scratch, ipywidgets, and streamlit can be found in the [comparisons](#) document.

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# A Mature Tech stack on top of Dear ImGui

Fiatlight is built on top of several powerful libraries and tools, including [Dear ImGui](#), [Hello ImGui](#), and [Dear ImGui Bundle](#).

# Dear ImGui



[Dear ImGui](#) is a *Bloat-free Graphical User interface for C++ with minimal dependencies*

Dear ImGui is a simple and powerful immediate mode GUI library, designed to be easy to integrate and use. It is written in C++, but can be used in many other languages, including Python. It is extremely lightweight and performant, and can be used in a wide range of applications, from games to scientific simulations.

## Documented Python bindings

Thanks to [Dear ImGui Bundle](#), python bindings for ImGui [are available](#), and it can even be used from within a Jupyter notebook.

They reproduce the C++ API in python with high fidelity, and are extensively documented. What's more they are **autogenerated**, so that they are always very close to the latest greatest version.

## Dear ImGui is an immediate mode C++ GUI library

In an immediate GUI, widgets display and event handling are done at the same time. For example:

- a call to `imgui.button("Click me")` will at the same time display the button and return true if it was clicked.

- a call to `imgui.input_text("some_label", some_string)` will display a text input and return a tuple `(changed, new_string_value)` where `changed` is true if the text was modified.

*Example: the following code will display a button and increment a counter when it is clicked:*

```
from imgui_bundle import imgui, immapp

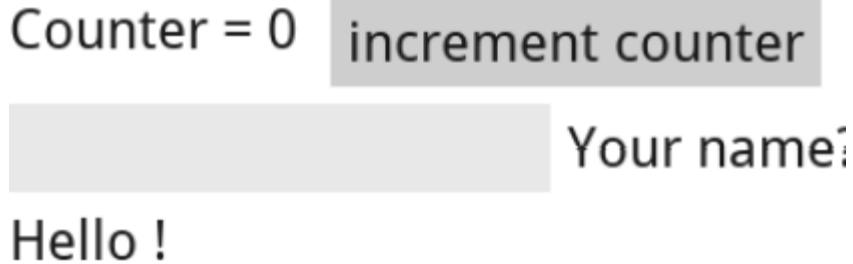
counter = 0
name = ""

def gui():
    global counter, name
    imgui.text("Counter = %i" % counter)
    imgui.same_line()

    if imgui.button("increment counter"):
        counter += 1

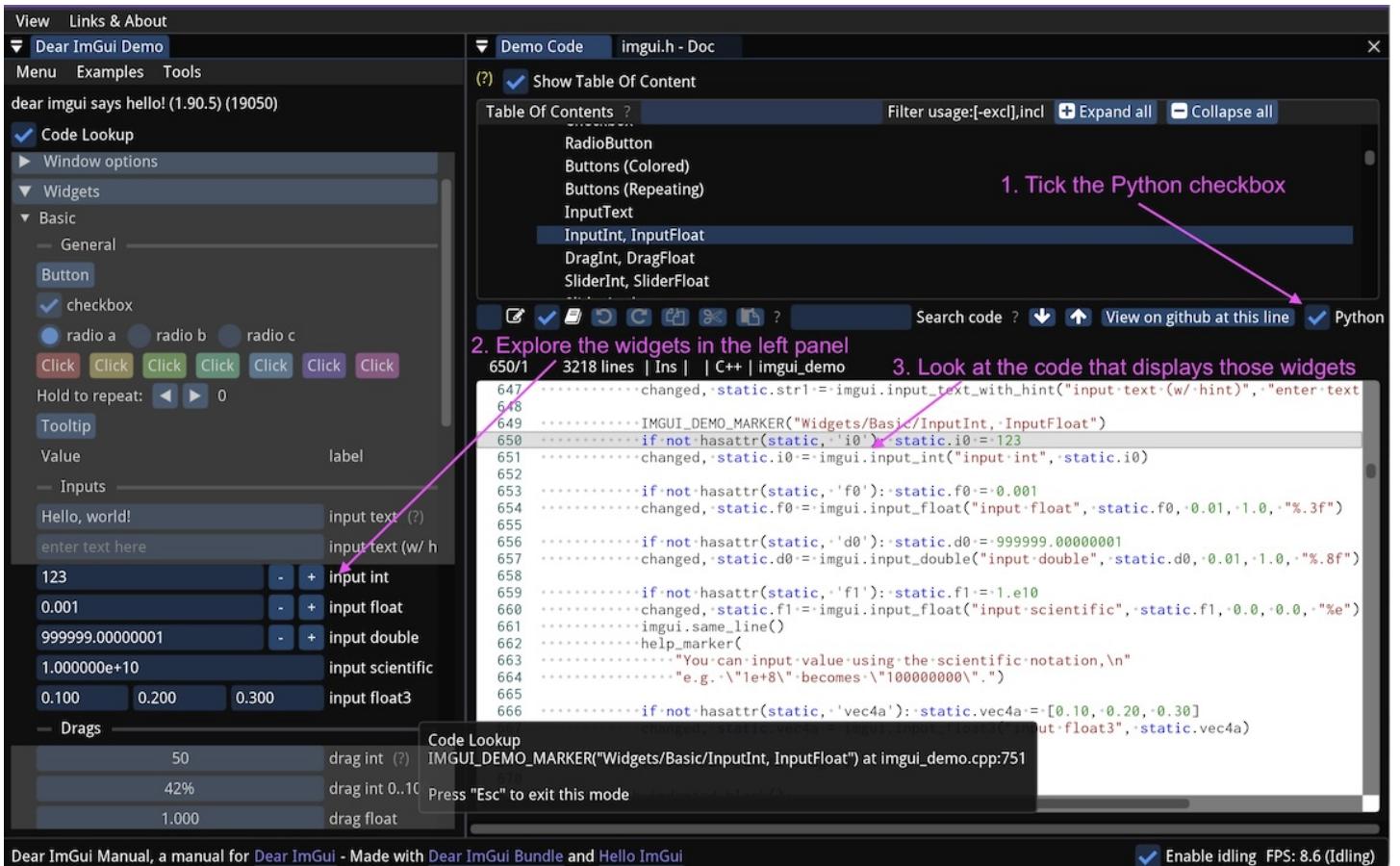
    changed, name = imgui.input_text("Your name?", name)
    imgui.text("Hello %s!" % name)

# Run the GUI in this notebook (and display a thumbnail afterwards)
immapp.run_nb(gui)
```



## ImGui is its own teacher!

Thanks to [ImGui Manual](#), you can explore the numerous ImGui widgets, and see the python code behind each.



1. Open the [manual](#)
2. Tick the "Python" checkbox
3. Explore the widgets on the left panel
4. See the corresponding python code on the right panel

## An extensively documented API

The [API for ImGui python bindings](#) is extensively documented, and gives you access to all the ImGui functions, along with their python and C++ signatures.

## Links

- Source: [ocornut/imgui](https://github.com/ocornut/imgui)
- Documentation:

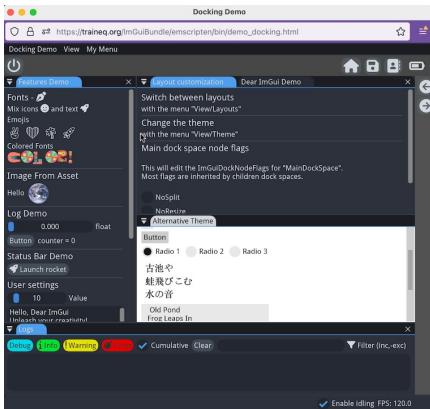
- Interactive Manual:  
[https://pthom.github.io/imgui\\_manual\\_online/manual/imgui\\_manual.html](https://pthom.github.io/imgui_manual_online/manual/imgui_manual.html)
    - Wiki: [ocornut/imgui](#)
  - Gallery & Real world apps: [ocornut/imgui#7503](#)
  - Python Bindings, with Dear ImGui Bundle (autogenerated): [pthom/imgui\\_bundle](#)
- 

## Hello ImGui



[Hello ImGui](#) is a library designed to make multiplatform app development as simple as writing a “Hello World” program, built on top of Dear ImGui.

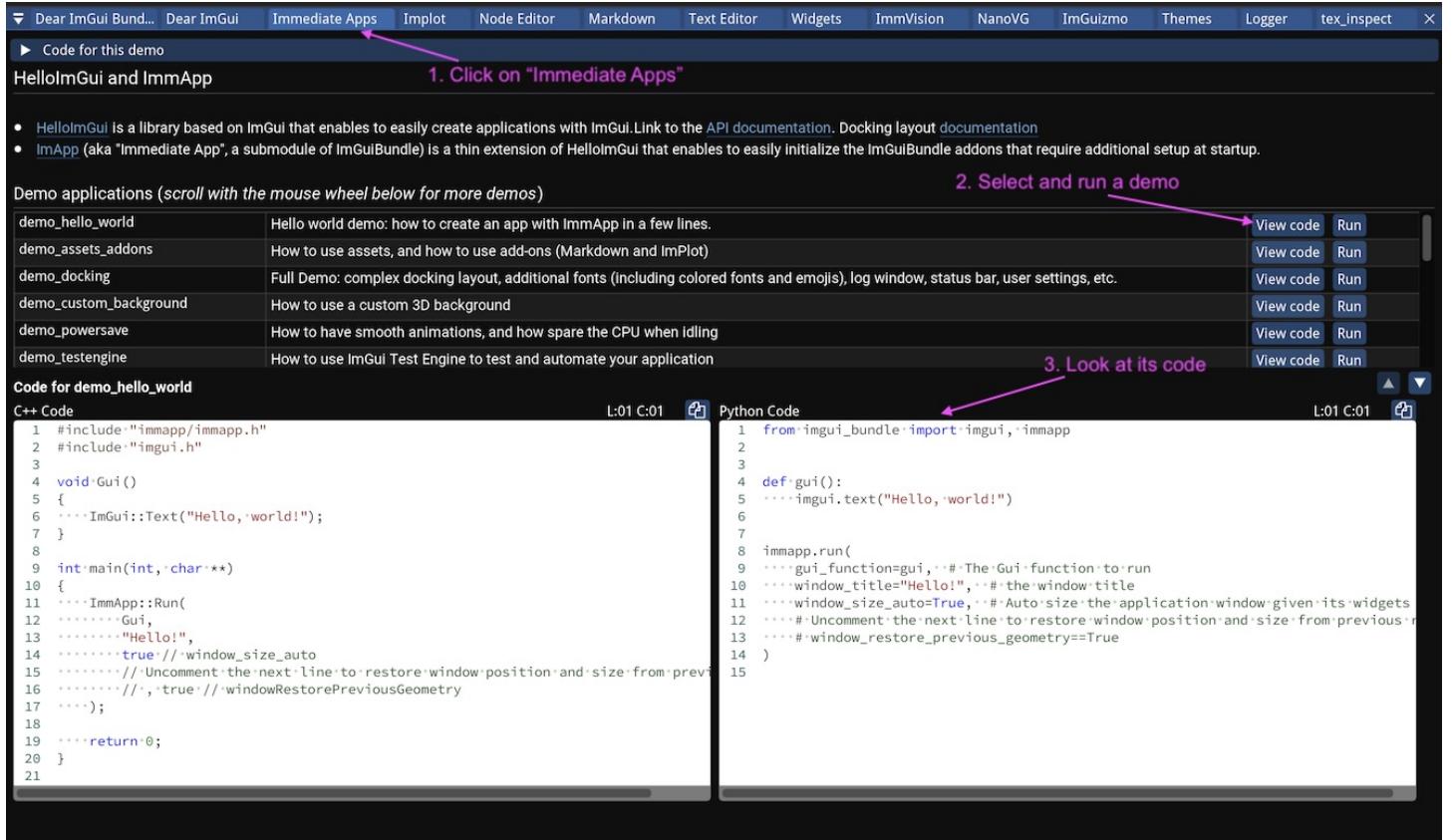
Thanks to [Dear ImGui Bundle](#), python bindings for Hello ImGui [are available](#).



(An advanced [tutorial](#) with Hello ImGui. Click the image to run it)

# Extensive tutorials and demos

The demo for [Dear ImGui Bundle](#) provides great tutorials for the usage of Hello ImGui in python:



1. Open the [demo](#)
2. Click on the “Immediate Apps” tab
3. Explore the various demos, run them, and see the python code behind each

# An extensively documented API

The [API for the python bindings](#) is extensively documented, and gives you access to all the classes and functions, along with their python and C++ signatures.

# Links

- Source: [!\[\]\(20137b0901404e96afbe12e82eed1e70\_img.jpg\) pthom/hello\\_imgui](https://github.com/pthom/hello_imgui)
  - Documentation: [https://pthom.github.io/hello\\_imgui](https://pthom.github.io/hello_imgui)
  - Demos & Real world apps: [https://pthom.github.io/hello\\_imgui/book/intro.html#demos-real-world-apps](https://pthom.github.io/hello_imgui/book/intro.html#demos-real-world-apps)
  - Python Bindings, with Dear ImGui Bundle ( autogenerated ): [!\[\]\(1f387dc7563b7c20b7f133e06d247528\_img.jpg\) pthom/imgui\\_bundle](https://github.com/pthom/imgui_bundle)
- 

## Dear ImGui Bundle



[Dear ImGui Bundle](#): easily create *ImGui* applications in Python and C++. Batteries included!

Dear ImGui Bundle is an extensive bundle for Dear ImGui, featuring [many powerful libraries](#) from its ecosystem. It can be used in C++ and Python, across Windows, macOS, Linux, iOS, Android, as well as in Web apps. It is ideal for application developers, and researchers eager to dive into GUI development with ease and efficiency.

## Extensive documentation and tutorials

The [Dear ImGui Bundle documentation](#) provides a comprehensive guide to the various libraries and tools available in the bundle.

The [online interactive demo](#) showcases the capabilities of the bundle, and provides a hands-on experience with the tools and libraries it offers and many tutorials (the code for all demos can easily be accessed from within the interactive demo).

## An ecosystem of powerful libraries

All the [numerous libraries](#) provided by the bundle are extensively documented, and can be used in both C++ and Python. The [bindings for all of these libraries](#) are also extensively documented.

What's more, the bindings are generated automatically by a powerful [bindings generator](#), so that they are always up-to-date.

## Links

- Source: [pthom/imgui\\_bundle](https://github.com/pthom/imgui_bundle)
  - Documentation: [https://pthom.github.io/imgui\\_bundle](https://pthom.github.io/imgui_bundle)
  - Included Libraries: [https://pthom.github.io/imgui\\_bundle/introduction.html](https://pthom.github.io/imgui_bundle/introduction.html)
  - Interactive Demo & Manual:  
[https://traineq.org/ImGuiBundle/emscripten/bin/demo\\_imgui\\_bundle.html](https://traineq.org/ImGuiBundle/emscripten/bin/demo_imgui_bundle.html)
  - Gallery: [pthom/imgui\\_bundle#107](https://github.com/pthom/imgui_bundle#107)
  - Autogenerated and documented Python Bindings, for all the included libraries:  
[pthom/imgui\\_bundle](https://github.com/pthom/imgui_bundle)
- 

## Python Bindings: from C++ to Python

The python bindings for all the libraries are autogenerated from the C++ API, and are extensively documented.

## How to use a C++ function in Python

There are two rules of thumbs that were applied when translating the APIs from C++ to Python:

- The names of functions and class members are transformed from CamelCase (C++) to snake\_case (Python)
- When a C++ function modifies an argument passed by pointer and returns a bool, the equivalent python function will return a tuple `(changed, new_value)`, where `changed` is a boolean indicating whether the value was modified.

For example, the following C++ function from ImGui,

```
IMGUI_API bool SliderFloat(const char* label, float* v, float v_min, float
```

is translated to the following python function:

```
def slider_float(
    label: str, v: float, v_min: float, v_max: float, format: str = "%.3", flags: S
) -> Tuple[bool, float]:
    pass
```

### **Example with Dear ImGui:**

[This part](#) of the ImGui C++ API is equivalent to [this part](#) of the Python API.

### **Example with Hello ImGui:**

[This part](#) of the Hello ImGui C++ API is equivalent to [this part](#) of the Python API.

### **More details:**

For more detail refer to the [C++ / Python porting advices](#) section of the Dear ImGui Bundle documentation.

# Installation

## Installation from source

```
%%bash

git clone https://github.com/pthom/fiatlight.git --branch refact_io
cd fiatlight

# Optional: create a virtual environment
# (you can use whichever method you prefer)
python3 -m venv venv
source venv/bin/activate

pip install -r requirements.txt
pip install -v -e .
```

## Install imgui-bundle (from the main branch)

Fiatlight relies on imgui-bundle, and will depend on the latest version on the main branch (version 1.5.2 from pypi is not sufficient).

To install it, you can

- either clone it and install it from source:

```
git clone https://github.com/pthom/imgui_bundle.git
cd imgui_bundle
git submodule update --init --recursive # (1)
pip install -v . # (2)
pip install opencv-python
pip install pyGLM
```

- or download pre-compiled recent wheels from here: [pthom/imgui\\_bundle](#)

# Installation from PyPI

```
# Not available yet
```

## Install optional dependencies

Several requirements files are provided, which you can install via `pip install -r requirements-<name>.txt`:

- requirements.txt: basic requirements
- requirements-ai.txt: requirements for AI demos
- requirements-audio.txt: requirements for audio demos
- requirements-dev.txt: requirements for development

Note: for AI demos, you will have to install torch manually, as its installation is dependent on your system configuration. See <https://pytorch.org/get-started/locally/> (you will of course need a GPU to run the demos)

# Manual

The manual is separated in several sections:

- [First steps](#)
- [Wrapping Functions](#)
- [GUI Registry](#)
- [Customizing Widgets with Fiat Attributes](#)
- [Command line interface](#)
- [Functions Graph](#)
- [Validate inputs](#)
- [Dataclasses & Pydantic Models](#)
- [Custom types registration](#)

- [Run the demos](#)

## First steps

### Running a single function

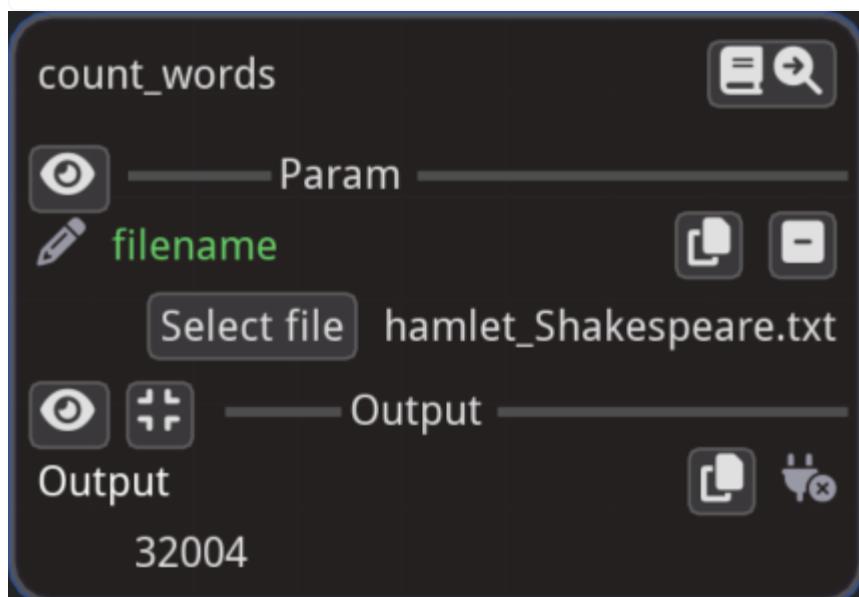
It is extremely simple to run and test a function with FiatLight. Below is a function that accepts a text path as a parameter and outputs the number of words in this text file.

```
import fiatlight as fl
# Note: TextPath is a synonym for str
#       Within fiatlight, it is associated with a file dialog widget
from fiatlight.fiat_types import TextPath

def count_words(filename: TextPath) -> int:
    """Count the number of words in a text file."""
    with open(filename, "r") as f:
        text = f.read()
    return len(text.split())

# Run the application
fl.run(count_words, app_name="Count Words")
```

2024-06-17 02:00:14.961 Python[41577:28952724] ApplePersistenceIgnoreState: Existing



## Composing two functions

Below we create a simple application with two functions: "int\_source" and "add":

- "int\_source" generates an integer value
- "add" adds two or three integer values.

We use the "@fl.with\_fiat\_attributes" decorator to specify the range of values for the input parameters of the functions.

Finally, we run the application using the "fl.run" function.

### Code

```

import fiatlight as fl

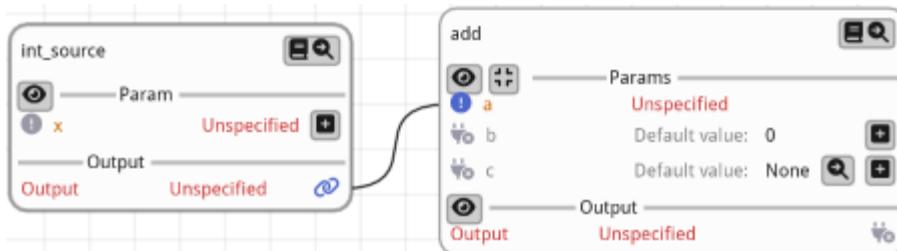
# Define int_source, using a decorator to specify the range of values for "x"
@fl.with_fiat_attributes(x__range=(0, 100))
def int_source(x: int) -> int:
    """int_source is the first function of the application
    Since it is not linked to any other function, fiatlight will ask
    the user to specify the value of "x".
    As such, it serves as a source for the next function.
    """
    return x

# Define add, using a decorator to specify the range of values for "a" and "b"
@fl.with_fiat_attributes(a__range=(0, 10), b__range=(0, 20))
def add(a: int, b: int = 0, c: int | None = None) -> int:
    """add is the second function of the application
    It adds the values of "a", "b", and "c" and returns the result.

    In the interface:
    - "a" is linked to the output of int_source and is unspecified
      until "x" is specified in int_source.
    - "b" is equal to its default value (0). It is shown in gray to
      indicate that it is using the default value.
    - "c" is an optional, equal to its default value (None). It is also shown in gray.
      In order to specify a value for "c", the user must first click on the
      "Set" button, to specify that this optional has a value, and then specify the
      value.
    """
    if c is None:
        c = 0
    return a + b + c

# Run the application, which is a GUI around the composition of the two functions
# Notes:
# - if running a single function, you can use fl.run(your_function)
# - the app_name parameter is optional. It defines the name of the settings file,
fl.run([int_source, add], app_name="First Example")

```



*The image above shows the default state of the application*

- int\_source:
  - “x” is unspecified
- add:
  - “a” is linked to the output of int\_source and is unspecified, since int\_source can not be executed (until “x” is specified)
  - “b” is equal to its default value (0). It is shown in gray to indicate that it is using the default value.
  - “c” is equal to its default value (None). It is also shown in gray.

## Video Tutorial of the available controls

*The video below shows how to interact with the widgets in a function node*

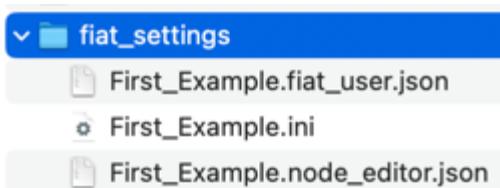
0:00

## Save / Load user settings

### Automatic user settings saving

Upon exit, Fiatlight automatically saves the user's settings in a folder named `fiat_settings` in the current directory.

The settings are named after the `app_name` param passed to `'fl.run` (if `app_name` is not set, the settings file will use the name of the main application module)



Three files are saved each time the application saves the settings:

- First\_Example.ini: settings for Dear ImGui (since and positions of the window)
- First\_Example.node\_editor.json: settings for the node editor (positions of the nodes)
- First\_Example.fiat\_user.json: settings for the user (values of the parameters of the functions)

## Manually save the user settings

When you manually save the user inputs by clicking on the buttons below,



only the user values are saved (in a file named "xxx.fiat\_user.json", where "xxx" is the file name you selected).

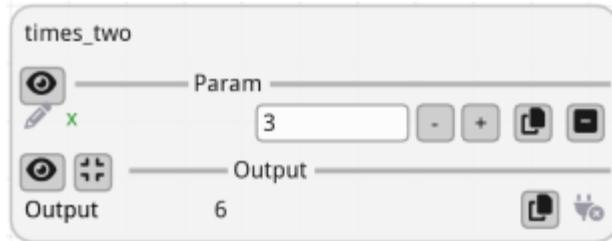
## Wrapping Functions

In this tutorial, we will see how to wrap functions in order to make them compatible with Fiatlight.

Most of the time, functions are wrapped automatically. In the example below, the function

`times_two` is wrapped automatically by Fiatlight into a `FunctionWithGui` object:

```
import fiatlight as fl
def times_two(x: int) -> int:
    return x * 2
fl.run(times_two, app_name="Times two") # the function will be wrapped automatically
```



In order to be wrapped automatically, a function must have a typed signature (see [Typed signatures](#)).

`FunctionWithGui` is one of the core classes of FiatLight: it wraps a function with a GUI that presents its inputs and outputs.

- **Documentation:** See its [API](#) for detailed information.
- **Source code:** View its full code [online](#).

## Typed Signatures

### Importance of Typed Signatures

To automatically create a GUI for function parameters, Fiatlight **requires** type information for both the parameters and the return value of the functions. This is achieved using type hints in the function signature.

For example, an untyped function signature looks like this:

```
def foo(a, b):
    return a + b
```

In contrast, a typed version is:

```
def foo(a: int, b: float) -> float:
    return a + b
```

More information about type hints can be found in [PEP 484](#). Type hints specify the type of a variable in Python. They are not mandatory but are a good practice, as they help catch bugs early in the development process.

## Typed vs Untyped Functions GUI

In the example below, `math.sin` and `math.cos` are unfortunately not typed. `my_cos` is a wrapper around `math.cos` that includes type information.

### Code

```
import math
import fiatlight as fl

def float_source(x: float) -> float:
    """A float source, where the user can specify the value of x."""
    return x

def my_cos(x: float) -> float:
    """A wrapper around math.cos that adds types,
    so that Fiatlight can infer the widgets in the GUI."""
    return math.cos(x)

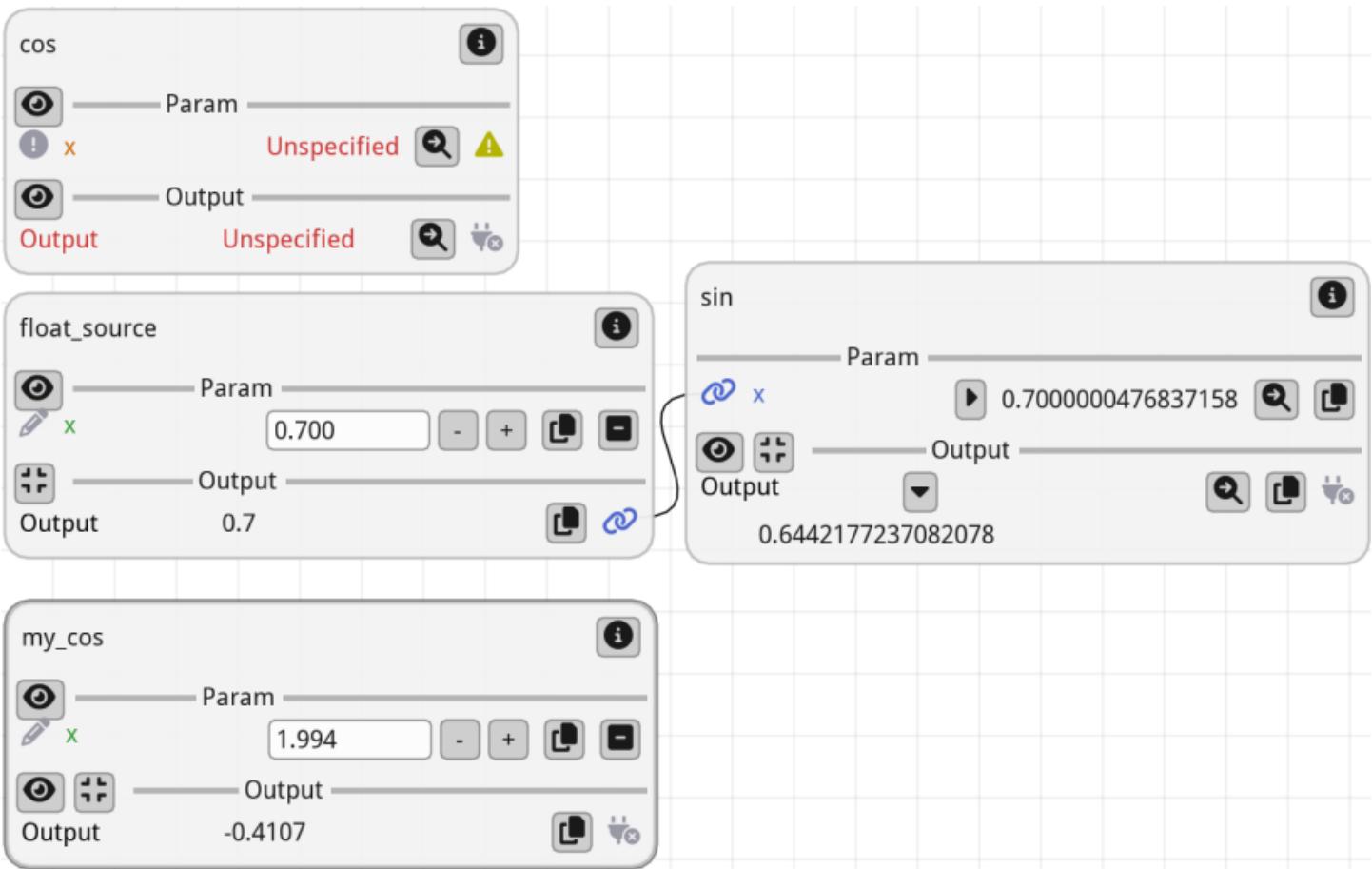
# We create a graph of functions, to which we will add functions manually
graph = fl.FunctionsGraph()

# Add a node that will run math.cos: since this function has no type information,
# Fiatlight **will not** be able to infer the widgets in the GUI)
graph.add_function(math.cos)

# Add a node that will run my_cos: since this function has type information,
# Fiatlight **will** be able to infer the widgets in the GUI
graph.add_function(my_cos)

# Add a function composition that will transfer the output of float_source to math.
# (in this case, math.sin will work correctly, since it only has to display the num
# and does not require an edition widget)
graph.add_function_composition([float_source, math.sin])

# Run the graph
fl.run(graph, app_name="Typed Signatures")
```



**Visual Output:** The image above shows the result of running the above code. Notice the differences in GUI behavior for typed vs untyped functions.

### Key Points:

- Since `cos` is untyped, it is impossible to enter a value for its input parameter.
- The function `sin`, however, works correctly in the graph since it receives an input from `float_source` and does not require an edition widget.

## Wrapping Functions

Creating a wrapper is often extremely simple and necessary when dealing with untyped functions. Wrapping a function allows you to add type information, making it compatible with Fiatlight's GUI capabilities. Let's see how to wrap the `math.cos` function.

### Why Create a Wrapper?

The `math.cos` function from Python's standard library does not have type annotations. Without these annotations, Fiatlight cannot automatically create a GUI for it. By creating a wrapper, we add

the necessary type information.

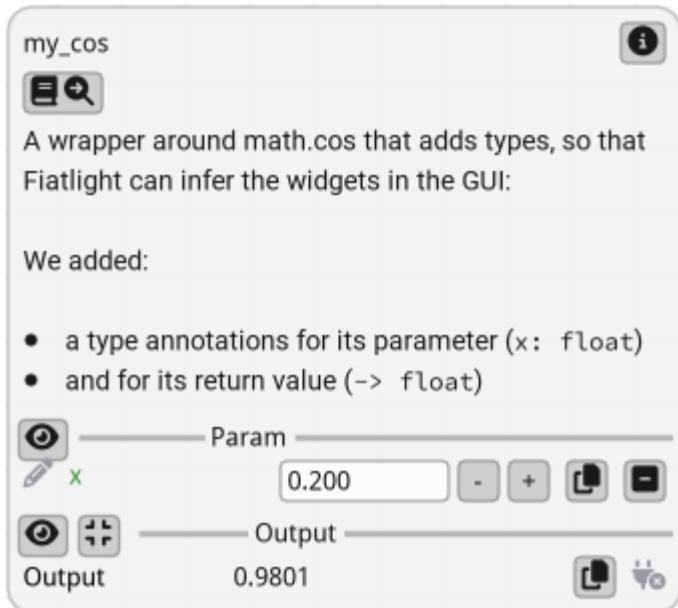
### Example: Wrapping `math.cos`

Below, we create a simple wrapper for `math.cos` that includes type annotations. This allows Fiatlight to generate a GUI for the function.

```
import math
import fiatlight as fl

# Original function without type annotations
def my_cos(x: float) -> float:
    """A wrapper around math.cos that adds types, so that Fiatlight can infer the wid
    We added:
        * a type annotations for its parameter (`x: float`)
        * and for its return value (`-> float`)
    """
    return math.cos(x)

# Run the wrapped function with Fiatlight
fl.run(my_cos, app_name="Wrapped Cosine Function")
```



When running the above code, Fiatlight generates a GUI that allows you to input a float value for `x` and see the result of `math.cos(x)`.

*As an additional benefit, the documentation you wrote in the wrapper is visible in the function node!*

# Registered Types

## Introduction

Fiatlight maintains a central registry that links data types (e.g., primitive types or custom data types) with GUI types. This registry allows Fiatlight to automatically create GUIs for functions based on their type annotations.

For more information:

- **Gui Registry:** See the [documentation](#) for detailed information
- **GUI Types:** The GUI Types are all descendant of `AnyDataWithGui`, which is a generic type that can be used to create custom widgets for your data types. See its [API](#).

## Using registered types

Registered types provide dedicated widgets, enabling automatic GUI creation for function parameters and outputs.

Tip: use the command `fiatlight types` in a terminal (or console) to list the registered types and their associated widgets. See "[Fiatlight command line utility](#)" for more information.

Below is an extract of the output of the `fiatlight types` command:

Data Type	Gui Type
int	IntWithGui A highly customizable int.
float	FloatWithGui A highly customizable float.
str	StrWithGui A Gui for a string with real multiline editing.
bool	BoolWithGui A bool widget. Can use a checkbox.
ColorRgb synonym for tuple[int, int, int] describing an RGB color, with values in [0, 255] (NewType)	ColorRgbWithGui A nice color picker for RGB colors.
...	...

## Example with Matplotlib Figures

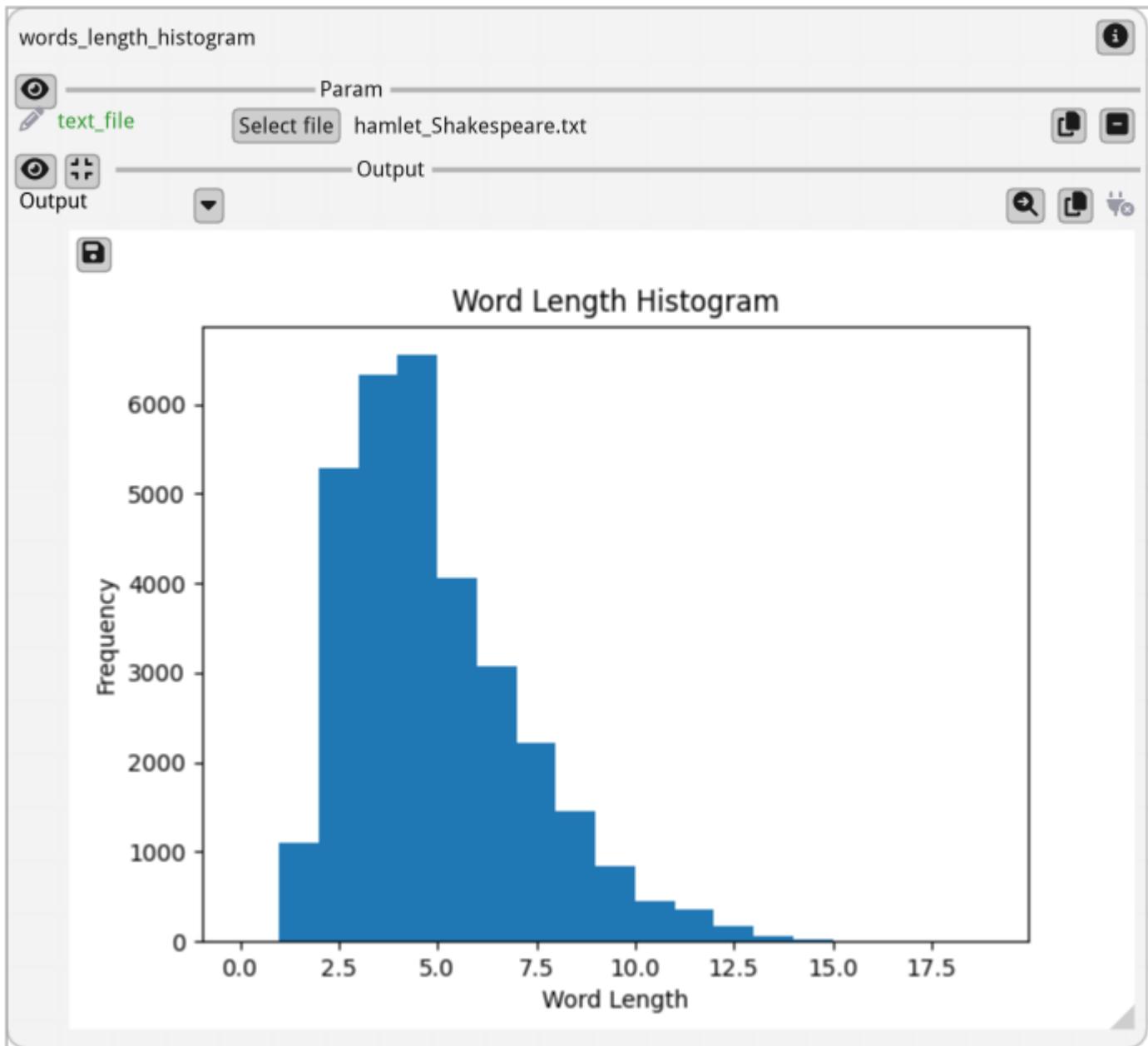
Let's look at an example using `TextPath` and `matplotlib.figure.Figure`, which are registered types in Fiatlight:

- `fl.flat_types.TextPath` is an alias for str, but it is registered to be displayed with a file selection dialog.
- `matplotlib.figure.Figure` is registered to be displayed as a plot in the GUI

```
import fiatlight as fl
import matplotlib.figure
import matplotlib.pyplot as plt

def words_length_histogram(text_file: fl.flat_types.TextPath) -> matplotlib.figure:
    "Create a histogram of the lengths of words in a text file."
    with open(text_file) as f:
        text = f.read()
    words = text.split()
    lengths = [len(word) for word in words]
    fig, ax = plt.subplots()
    ax.hist(lengths, bins=range(0, 20))
    ax.set_title("Word Length Histogram")
    ax.set_xlabel("Word Length")
    ax.set_ylabel("Frequency")
    return fig

fl.run(words_length_histogram, app_name="Registered types")
```



## Controlling Function Execution

By default, the function will be called only when one of its inputs has changed (either because the user entered a new value, or because an input is connected to another function that has changed).

You can control the behavior of the function by setting attributes on the function object.

- `invoke_async` (default=False): if set to True, the function will be called asynchronously
- `invoke_manually` (default=False): if set to True, the function will be called only if the user clicks on the "invoke" button

- `invoke_always_dirty` (default=False): if set to True, the function output will always be considered out of date. Depending on the value of `invoke_manually`:
  - if “`invoke_manually`” is True, the “Refresh needed” label will be displayed
  - if “`invoke_manually`” is False, the function will be called at each frame

*Note: a “live” function is thus a function with `invoke_manually=False` and `invoke_always_dirty=True`*

## Configuring “Live” functions

### Example: a live function that display a camera image

```
import fiatlight as fl
from fiatlight.fiat_kits.fiat_image import ImageU8_3
import cv2 # we use OpenCV to capture the camera image (pip install opencv-python)
cap = cv2.VideoCapture(0) # you will need a camera!

def get_camera_image() -> ImageU8_3 | None:
    ret, frame = cap.read()
    return ImageU8_3(frame) if ret else None

# Set flags to make this a live function (called automatically at each frame)
fl.add_fiat_attributes(get_camera_image, invoke_always_dirty=True)

fl.run(get_camera_image, app_name="Live camera image")
```



# Using Async Functions

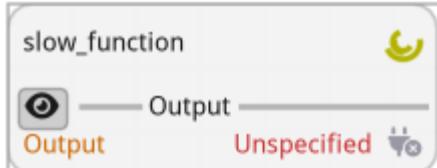
## Example: an async function

When your function is slow, you can set the `invoke_async` flag to True. In the example below, the yellow spinner indicates that the function is running, while keeping the GUI responsive.

```
import fiatlight as fl
import time
def slow_function() -> int:
    time.sleep(5)
    return 42

fl.add_fiat_attributes(slow_function, invoke_async=True)
fl.run(slow_function, app_name="Async function")

# Note:
# You can also use the `@fl.with_fiat_attributes` decorator to set the flags direct
# @fl.with_fiat_attributes(invocation_async=True)
# def slow_function() -> int:
#     ...
```



## "Stoppable" async Functions

In the case of async function, you may also set:

- `invoke_async_stoppable` (default=False): if true a GUI button will be displayed to stop the async function while it is running.

In this case, you will need to check the flag `invoke_async_shall_stop` in your function to know if the function should stop.

## Example:

```

def my_async_function():
    # ... # some initialization
    while True: # inner loop of the function processing (can be any form of loop)
        # ... # some processing
        if hasattr(my_async_function, "invoke_async_shall_stop") and my_async_func
            my_async_function.invoke_async_shall_stop = False # reset the flag
            break
    # ... # continue the function processing

```

## Manual Invocation Example

### Example: a function that needs to be called manually

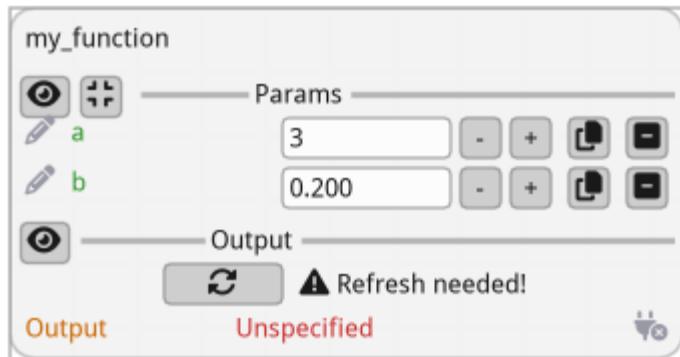
If you set the `invoke_manually` flag to True, the function will be called only when the user clicks the “invoke” button (indicated by a “recycle” icon). If the inputs have changed, a “Refresh needed” label will be displayed.

```

import fiatlight as fl
def my_function(a: int, b: float) -> float:
    return a + b

fl.add_fiat_attributes(my_function, invoke_manually=True)
fl.run(my_function, app_name="Manual invocation")

```



## Handwriting the GUI

### Using Edit and Present Callbacks

You can also customize the GUI for a parameter or output by setting custom callbacks function, namely the “edit” and “present” callbacks.

In this case, you will first wrap the function in a `FunctionWithGui` object, and then set the callbacks for the parameter or output.

```
import fiatlight as fl

def my_function(a: int) -> float:
    return a * 4

my_function_gui = fl.FunctionWithGui(my_function)

# A callback to edit the parameter. Receive the current value, and return a tuple (
# my_function_gui.input("a").callbacks.edit = ...

# A callback to present the output. Receive the current value, and return None
# my_function_gui.output().callbacks.present = ...
```

For more information, see:

- **AnyDataWithGui**: See the [API](#) for detailed information.
- **AnyDataWithGuiCallbacks**: See the [API](#) for detailed information.

## Example: Custom Callbacks

In this example, we define custom edit and present callbacks for the function `fahrenheit_to_celsius`. The resulting GUI allows the user to input a temperature in Fahrenheit using a custom slider and see the converted temperature in Celsius with a color-coded note indicating whether it is cold, warm, or hot.

```

import fiatlight as fl
from imgui_bundle import imgui, hello_imgui, ImVec4

def fahrenheit_to_celsius(fahrenheit: float = 0) -> float:
    return (fahrenheit - 32) * 5 / 9

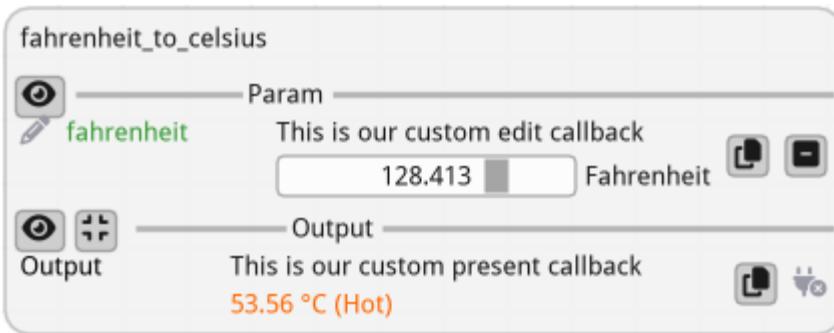
# This will be our edit callback: it accepts a float and returns a tuple (bool, float)
# where the first element is True if the value has changed, and the second element
def edit_temperature(fahrenheit: float) -> tuple[bool, float]:
    imgui.text("This is our custom edit callback")
    # Set the width of the slider field to 10 em units (using em units is a good pr
    imgui.set_next_item_width(hello_imgui.em_size(10))
    changed, new_value = imgui.slider_float("Fahrenheit", fahrenheit, -100, 200)
    return changed, new_value

# This will be our present callback: it accepts a float and returns None
def present_temperature(celsius: float) -> None:
    imgui.text("This is our custom present callback")
    note = "Cold" if celsius < 20 else "Hot" if celsius > 40 else "Warm"
    color = ImVec4(0, 0.4, 1, 1) if celsius < 20 else ImVec4(1, 0.4, 0, 1) if celsi
    imgui.text_colored(color, f"{celsius:.2f} °C ({note})")

fahrenheit_to_celsius_gui = fl.FunctionWithGui(fahrenheit_to_celsius)
fahrenheit_to_celsius_gui.output().callbacks.present = present_temperature
fahrenheit_to_celsius_gui.input("fahrenheit").callbacks.edit = edit_temperature

fl.run(fahrenheit_to_celsius_gui, app_name="Custom callbacks")

```



## Gui Nodes

Gui Nodes are specialized nodes in Fiatlight, dedicated to functions which do not return values but instead displaying a user interface using ImGui widgets. Gui Nodes are called at every frame, ensuring that the GUI is always responsive and up-to-date.

Gui Nodes are particularly useful for:

- Displaying interactive visualizations (plots, etc)
- Creating dashboards
- Providing user controls (e.g., sliders, buttons) that alter global variables

Notes:

- Gui Nodes are not meant to return values
- Your GUI function should be fast. If you need to perform heavy computations, consider using AnyDataWithGui, where the "on\_change" callback can be used to cache heavy computations.

## Example: Visualizing a Heart Curve with a GUI Node

In this example, we demonstrate how to create a GUI node that visualizes a heart curve. The size of the heart dynamically changes over time to simulate a heartbeat.

### Explanation:

1. `time_seconds`: This function returns the current time in seconds and is set to always be re-evaluated at every frame.
2. `heart_curve`: Generates the x and y coordinates of a heart curve that changes size over time to simulate a heartbeat.
3. `gui_curve`: A GUI node that visualizes the heart curve using ImPlot. It updates the curve at every frame to reflect the beating heart.
4. `gui_curve` is a `gui` function. So, we wrap it in a `GuiNode` to display the heart curve with either `GuiNode(gui_curve)` or `graph.add_gui_node(gui_curve)`.

```

import fiatlight as fl
from imgui_bundle import hello_imgui, implot
import numpy as np
from numpy.typing import ArrayLike
import time

@fl.with_fiat_attributes(invoker_always_dirty=True)
def time_seconds() -> float:
    """Return the current time in seconds.
    This function is marked as always dirty, so it will be re-evaluated at every frame.
    """
    return time.time()

def heart_curve(time_: float) -> ArrayLike:
    """Return the x and y coordinates of a heart curve whose size changes over time
    to simulate a heart beating.
    """
    vals = np.arange(0, np.pi * 2, 0.01)
    x0 = np.power(np.sin(vals), 3) * 16
    y0 = 13 * np.cos(vals) - 5 * np.cos(2 * vals) - 2 * np.cos(3 * vals) - np.cos(4 * vals)

    # Heart pulse rate and time tracking
    heart_pulse_rate = 80
    phase = time_ * heart_pulse_rate / (np.pi * 2)
    k = 0.8 + 0.1 * np.cos(phase)
    return np.array([x0 * k, y0 * k])

def gui_curve(xy: ArrayLike) -> None:
    """Display the heart curve with ImPlot

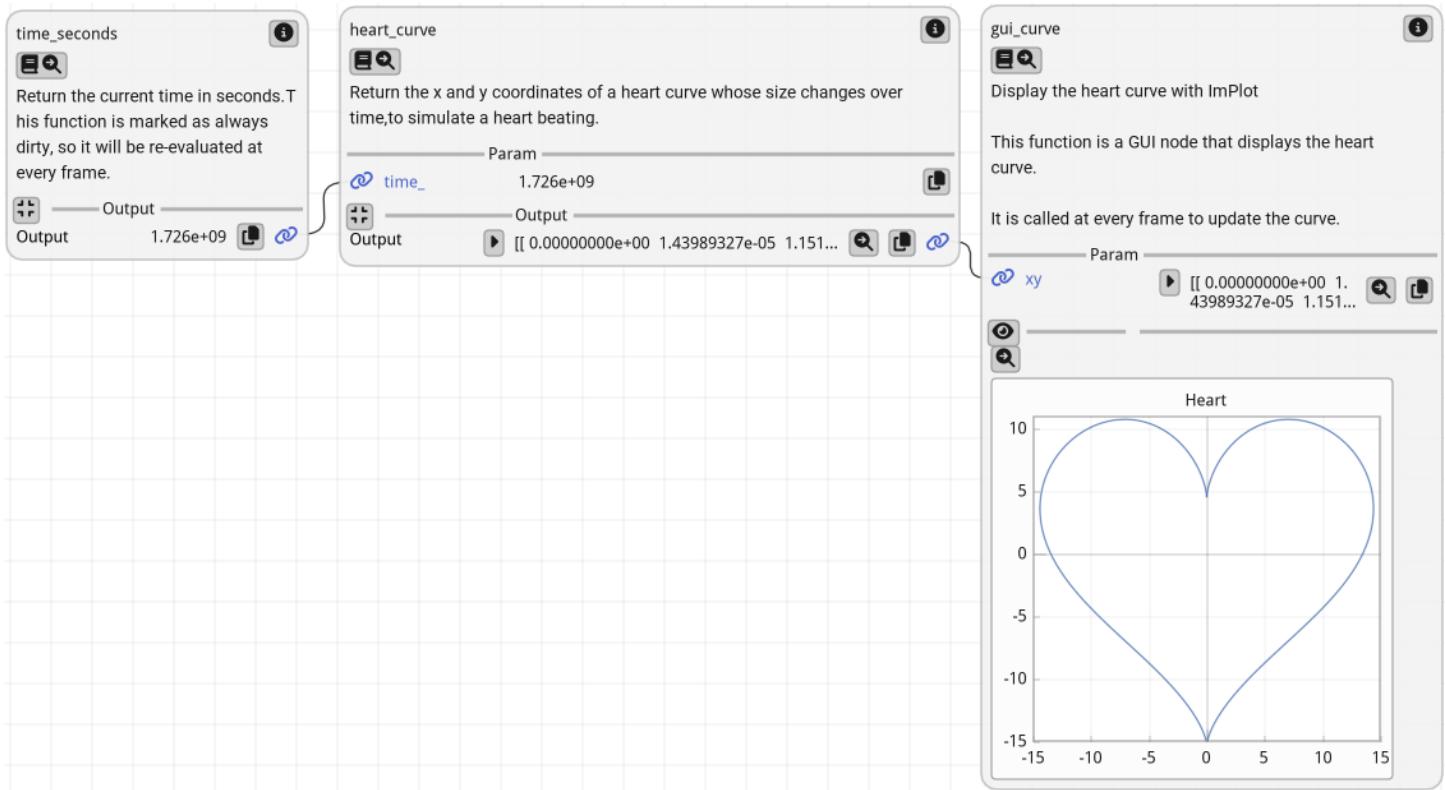
    This function is a GUI node that displays the heart curve.

    It is called at every frame to update the curve.
    """
    if implot.begin_plot("Heart", hello_imgui.em_to_vec2(21, 21)):
        implot.setup_axes_limits(-15, 15, -15, 11)
        implot.plot_line("", xy[0], xy[1])
    implot.end_plot()

# Run the graph
# Method 1: Using the run function, and wrapping the gui_curve function in a GuiNode
fl.run([time_seconds, heart_curve, fl.GuiNode(gui_curve)], app_name="HeartCurve")

# Method 2: Using a FunctionsGraph
# graph = fl.FunctionsGraph()
# graph.add_function(time_seconds)
# graph.add_function(heart_curve)
# graph.add_gui_node(gui_curve) # Add the gui_curve function as a GuiNode
# graph.add_link(time_seconds, heart_curve)
# graph.add_link(heart_curve, gui_curve)
# fl.run(graph, app_name="HeartCurve")

```



## Example: a GUI node with serializable state

When adding a GuiNode, you can pass a serializable data class to store the options of the GUI function. This allows you to save the state of the GUI function and reload it when restarting the application.

In the example below, we demonstrate how to create a GUI node that multiplies an input value by a factor. The factor can be adjusted by the user and is stored in a serializable data class. The factor value is reloaded upon restarting the application.

```

import fiatlight as fl
from imgui_bundle import imgui
from pydantic import BaseModel

def input_x(x: int) -> int:
    """A function that will be displayed in the function graph, in order to let the
    return x

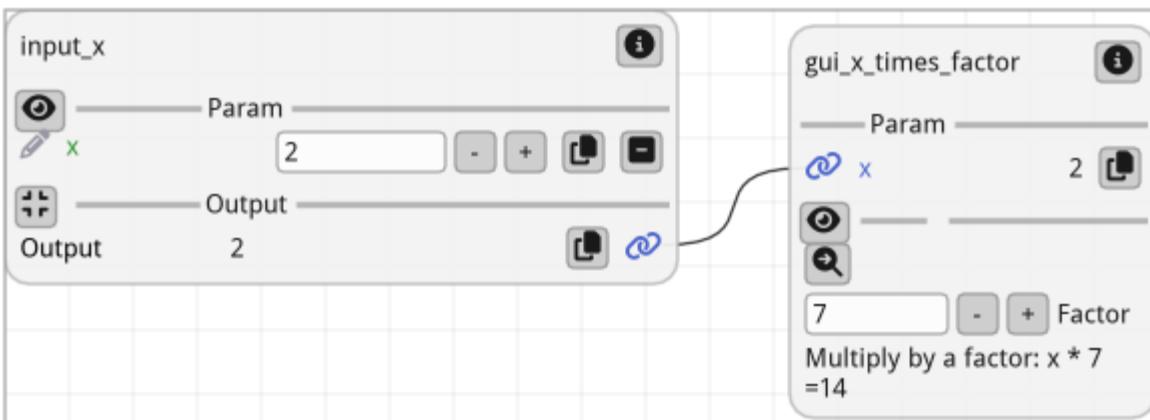
class WhatToMultiply(BaseModel):
    """A serializable data class that will be used to store the options of the GUI
    factor: int = 3

WHAT_TO_MULTIPLY = WhatToMultiply()

def gui_x_times_factor(x: int) -> None:
    """A GUI function that multiplies the input by a serializable factor.
    It will be added via graph.add_gui_node(gui_x_times_factor, gui_serializable_da
    It uses a serializable data class to store its options, which will be reloaded
    """
    _, WHAT_TO_MULTIPLY.factor = imgui.input_int("Factor", WHAT_TO_MULTIPLY.factor)
    imgui.text(f"Multiply by a factor: x * {WHAT_TO_MULTIPLY.factor} ={x * WHAT_TO_"

# Run the graph
fl.run([input_x, fl.GuiNode(gui_x_times_factor, gui_serializable_data=WHAT_TO_MULTIPLY)])

```



## Debugging Functions exceptions

When a function raises an exception, Fiatlight catches and displays it without crashing the application. Instead, you will see a “Debug this exception” button that you can use to trigger the exception again.

This feature is invaluable for debugging and making your functions more robust. If you are using a debugger, you will be taken directly to the point where the exception occurred, with the correct inputs to reproduce the bug.

\_Note: this feature can be disabled with:

```
fl.get_fiat_config().run_config.catch_function_exceptions = False
```

## Example: a Math Exception

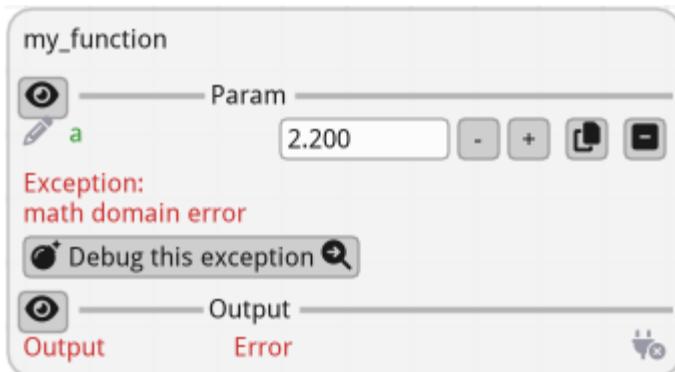
With this setup, if the input value of `a` causes `math.log(cos_a)` to produce an error (when `cos_a` is negative).

Fiatlight will catch and display the exception, allowing you to debug it easily.

```
import fiatlight as fl
import math

def my_function(a: float) -> float:
    cos_a = math.cos(a)
    r = math.log(cos_a)
    return r

fl.run(my_function, app_name="Math domain exception")
```



## Fiat Tuning: Tune functions

### Introduction

Fiatlight provides you with powerful tools to visually debug the intermediate states of your function.

By adding a `fiat_tuning` attribute to a function, you can provide additional information that will be displayed in the GUI node for this function. This attribute is a dictionary and can contain named

data values or descendants of AnyWithDataWithGui. This information can be used to fine-tune the function, debug it, or visualize intermediate states.

Moreover, this information can be updated in the GUI, even if the function is a long-running process called asynchronously.

*Example: The image below shows a sort competition between different algorithms. The GUI nodes display in real time the evolving state of each algorithm, using “fiat\_tuning” (see tutorial “demos/tutorials/sort\_competition” for more details).*



## Example: Measure Execution Time

In the example below, we will add a simple float into the fiat\_tuning attribute of the sort\_list function. This float will represent the duration of the sort operation.

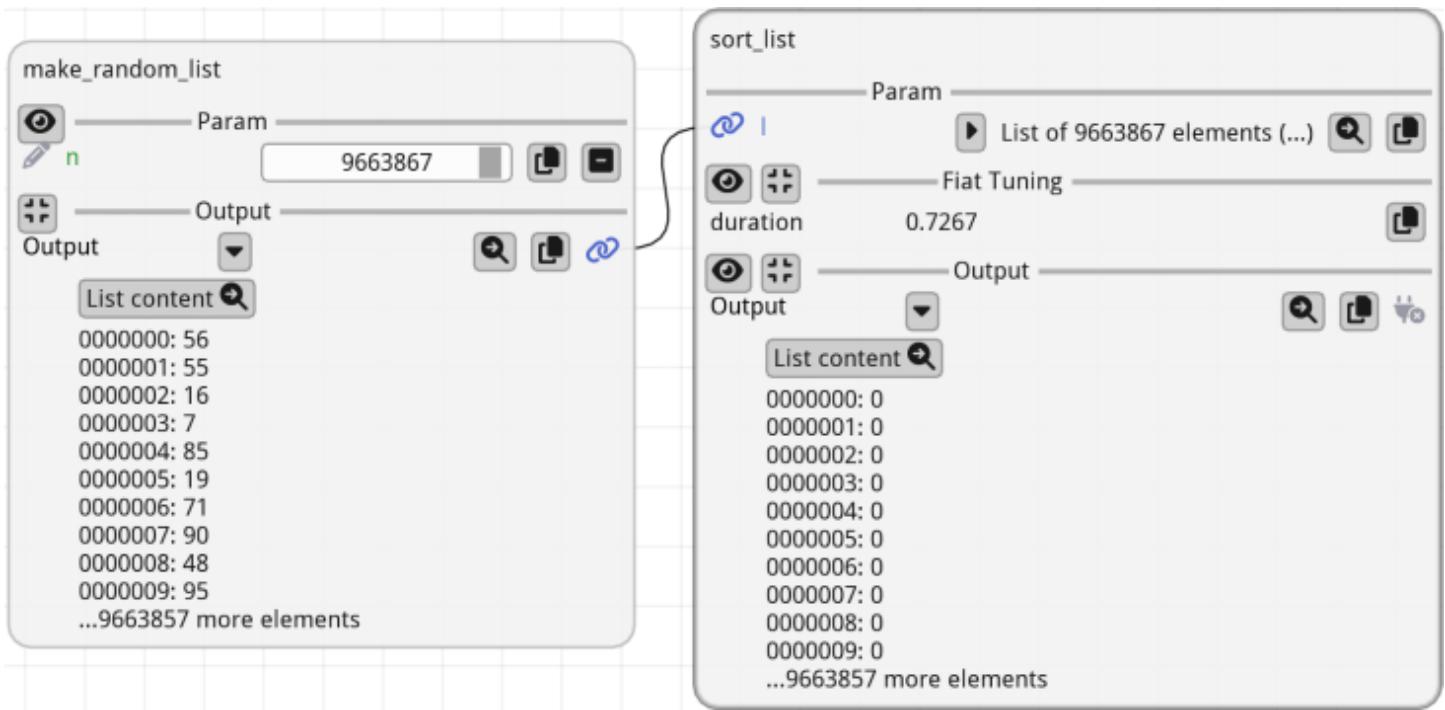
The collapsible region “Fiat Tuning” will display this duration:we can see that in this example, it takes about 0.75 seconds to sort a list of 10,000,000 elements.

```
import fiatlight as fl
import time

@fl.with_fiat_attributes(n__range=(1, 10_000_000))
def make_random_list(n: int) -> list[int]:
    import random
    return [random.randint(0, 100) for _ in range(n)]


def sort_list(l: list[int]) -> list[int]:
    start = time.time()
    r = sorted(l)
    duration = time.time() - start
    fl.add_fiat_attributes(sort_list, fiat_tuning={"duration": duration})
    return r

fl.run([make_random_list, sort_list], app_name="Sort duration")
```



## Example: Tune using an Image

The `fiat_tuning` attribute can also be used to display widgets (which must be descendants of `AnyWithDataWithGui`) in the GUI node.

In the example below, we will add an image widget (`ImageWithGui`) into the `fiat_tuning` attribute.

[`demos/images/toon\_edges.py`](#) is a good example of how to use the `fiat_tuning` attribute.

`add_toon_edges` is a complex function that adds a toon effect to an image, by adding colored edges to the image contours. The contour detection is extremely sensitive to the parameters, and the `fiat_tuning` attribute is used to display the intermediate states of the function in the GUI.

Here are some commented extracts of the function:

```

from fiatlight.fiat_kits.fiat_image import ImageU8_3, ImageU8_1

def add_toon_edges(
    image: ImageU8_3,
    # ... lots of parameters ...
) -> ImageU8_3:
    edges: ImageU8_1 # = ...           (compute the edges)
    dilated_edges: ImageU8_1 # = ...   (dilate the edges)
    image_with_edges: ImageU8_3 # = ... (superimpose the edges on the image)

    # fiat_tuning: add debug internals to ease fine-tuning the function inside the
    from fiatlight.fiat_kits.fiat_image import ImageWithGui

    # Add to fiat_tuning any variable you want to be able to fine-tune or debug in
    #     * Either a raw type (int, float, str, etc.): see durations
    #     * Or a descendant of AnyDataWithGui: see "canny", "dilate", "image_with_e
    fl.add_fiat_attributes(add_toon_edges, fiat_tuning={
        "duration_canny": duration_canny,
        "duration_dilate": duration_dilate,
        "duration_blur": duration_blur,
        "duration_merge": duration_merge,
        "canny": ImageWithGui(edges),
        "dilate": ImageWithGui(dilated_edges),
        "image_with_edges": ImageWithGui(image_with_edges),
    })

    # return the image with edges
    return image_with_edges

```

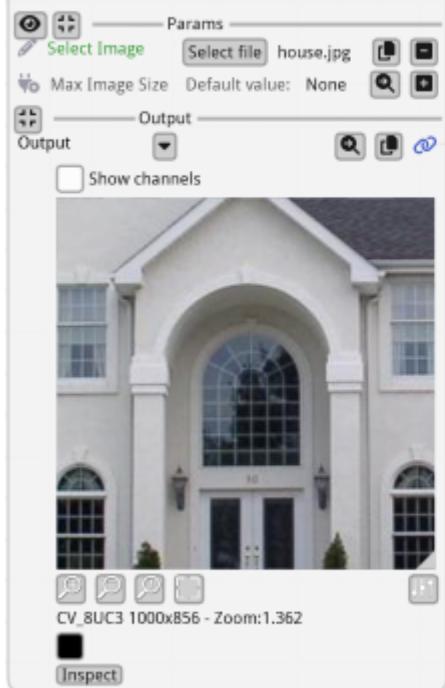
Once these internals are set, you can see the function “Internals” in the GUI:

```

import fiatlight as fl
from fiatlight.fiat_kits.fiat_image import ImageU8_GRAY, ImageU8_3, image_source
from fiatlight.demos.images.toon_edges import add_toon_edges

fl.run([image_source, add_toon_edges], app_name="Toon edges")

```



**Add Toon Edges**

Params

image Image (856, 1000, 3) uint8

Edges Params

canny

- t\_lower 3674 (0 ... 1e+04)
- t\_upper 4.332e+04 (0 ... 1e+05)
- l2\_gradient
- blur\_sigma 0.000
- aperture\_size APERTURE\_3
- dilate kernel\_size=3 morph\_shape=cMorphShape.MORPH\_ELLIPSE
- appearance blur\_sigma=0.0 intensity=0.8 color=(23, 23, 23)

Flat Tuning

- duration\_canny 0.003155
- duration\_dilate 0.0003729
- duration\_blur 9.537e-07
- duration\_merge 0.08703
- canny

CV\_8UC1 1000x856 - Zoom:0.930

[Inspect]

dilate

CV\_8UC1 1000x856 - Zoom:0.930

[Inspect]

image\_with\_edge\_

Show channels

CV\_8UC3 1000x856 - Zoom:0.930

[Inspect]

Output

Show channels

The image above shows the GUI node for the `toon_edges` function, with the expanded "Fiat Tuning" section: it displays the execution time of each step, as well as an image representation of the intermediate edges and dilated edges.

## Sub-class FunctionWithGui

### Introduction

By subclassing `FunctionWithGui`, you can fully customize the behavior of the function:

- you can add a GUI for the internal state of the function (e.g. displaying a live plot of a sound signal)
- you can add a heartbeat function that will be called at each frame (e.g. get the latest data from a sensor)
- you can save and load the internal GUI presentation options to/from a JSON file (e.g. to save the layout of a plot)

### Example: Camera & Internal State

[`fiatlight.fiat\_kits.fiat\_image.CameralmageProviderGui`](#) is a good example of a custom `FunctionWithGui` class.

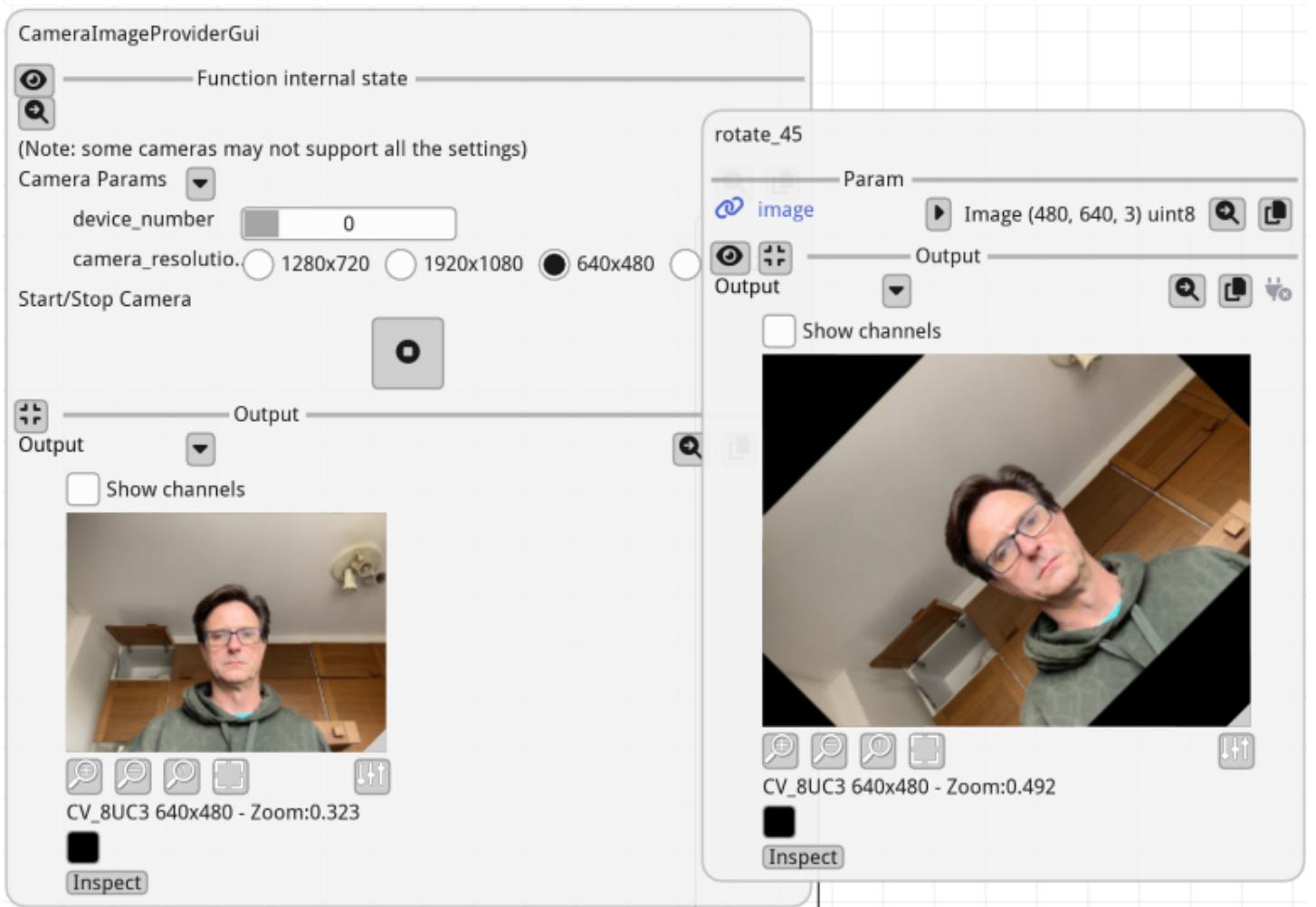
You can see it in action below:

```
import fiatlight as fl
from fiatlight.fiat_kits.fiat_image import CameraImageProviderGui, ImageU8_3
import cv2

def rotate_45(image: ImageU8_3) -> ImageU8_3:
    transform = cv2.getRotationMatrix2D((image.shape[1] / 2, image.shape[0] / 2), 45)
    return cv2.warpAffine(image, transform, (image.shape[1], image.shape[0])) # try

camera_provider_gui = CameraImageProviderGui()
fl.run([camera_provider_gui, rotate_45], app_name="Camera provider with rotation")
```

2024-09-14 15:42:54.462 Python[44008:11709418] WARNING: AVCaptureDeviceTypeExternal



## Commented extracts of [camera\\_image\\_provider.py](#)

Look at the `CameraImageProviderGui` class that extends `FunctionWithGui`:

Notes:

- `CameraImageProviderGui` der uses a `CameraImageProvider` class that provides images from a camera.
- `CameraParams` contains the state of the camera (device number, brightness, contrast, etc.). This state is serialized. As it is as a Pydantic model, a GUI for it is automatically created by Flatlight, and its state is serialized.

`CameralImageProviderGui` (a descendant of `FunctionWithGui`):

```
from fiatlight.fiat_notebook import look_at_code
%look_at_python_code
fiatlight.fiat_kits.fiat_image.camera_image_provider.CameraImageProviderGui
```

```

class CameraImageProviderGui(FunctionWithGui):
    """A Gui for the camera image provider"""

    _camera_provider: CameraImageProvider
    _camera_params_gui: AnyDataWithGui[CameraParams]

    def __init__(self) -> None:
        super().__init__(self.f, "CameraImageProviderGui")

        from fiatlight.flat_togui import to_data_with_gui

        self._camera_provider = CameraImageProvider()
        self._camera_params_gui = to_data_with_gui(self._camera_provider.camera_params)
        self._camera_params_gui.label = "Camera Params"

        self.internal_state_gui = self._internal_state_gui
        self.save_internal_gui_options_to_json = self._save_internal_gui_options_to_json
        self.load_internal_gui_options_from_json = self._load_internal_gui_options_from_json

    # A flag for fiatlight to set this as a live function
    self.invoke_always_dirty = True

    def f(self) -> ImageU8_3 | None:
        return self._camera_provider.get_image()

    def _save_internal_gui_options_to_json(self) -> JsonDict:
        r = self._camera_provider.camera_params.model_dump(mode="json")
        return r

    def _load_internal_gui_options_from_json(self, json_dict: JsonDict) -> None:
        camera_params = CameraParams.model_validate(json_dict)
        self._camera_provider.camera_params = camera_params
        self._camera_params_gui.value = camera_params

    def _show_cam_button(self) -> None:
        started = self._camera_provider.started()
        with imgui_ctx.begin_horizontal("CamButton"):
            imgui.spring()
            button_size = hello_imgui.em_to_vec2(3, 3)
            if not started:
                if imgui.button(Icons_FontAwesome_6.ICON_FA_CIRCLE_PLAY, button_size):
                    self._camera_provider.start()
            else:
                if imgui.button(Icons_FontAwesome_6.ICON_FA_CIRCLE_STOP, button_size):
                    self._camera_provider.stop()
            imgui.spring()

    def _internal_state_gui(self) -> bool:
        with fontawesome_6_ctx():
            with imgui_ctx.begin_vertical("CamParams"):
                imgui.text_wrapped("(Note: some cameras may not support all the settings)")
                changed = self._camera_params_gui.gui_edit()
                if changed:

```

```

        assert isinstance(self._camera_params_gui.value, CameraParams)
        self._camera_provider.apply_params(self._camera_params_gui.value)
        imgui.text("Start/Stop Camera")
        self._show_cam_button()

    return False

```

## CameraParams (serialized internal state):

```

import fiatlight as fl
from enum import Enum
from pydantic import BaseModel
import cv2

class CameraResolution(Enum):
    HD_1280_720 = [1280, 720]
    FULL_HD_1920_1080 = [1920, 1080]
    VGA_640_480 = [640, 480]

@fl.base_model_with_gui_registration(device_number__range= (0, 5), brightness__range=(0.0, 1.0))
class CameraParams(BaseModel):
    device_number: int = 0
    brightness: float = 0.5
    contrast: float = 0.5
    camera_resolution: CameraResolution = CameraResolution.VGA_640_480

class CameraImageProvider:
    '''A class that provides images from a camera'''
    camera_params: CameraParams
    cv_cap: cv2.VideoCapture | None = None
    ...

```

## Gui Registry

`fiatlight.fiat_togui` is the central module that is able to associate a GUI with a type.

It uses sophisticated mechanisms to inspect the type of function parameters and return values.

It handles a registry of types and their associated GUIs, to which you can add your own types, by calling `fiatlight.register_type(DataType, DataTypeWithGui)`, where `DataType` is the type you want to register, and `DataTypeWithGui` is the class that will handle the GUI for this type.

`DataTypeWithGui` must inherit from `AnyDataWithGui` and implement the necessary callbacks.

# Explore the registry

The `fiatlight` command line utility is a powerful tool that allows you to explore the available widgets and types in Fiatlight. It can be used to list the available types, to print the GUI info for a given type, and to run a GUI demo for a given type.

Here is the help message for the `fiatlight` command line utility:

```
%%bash
fiatlight --help
```

```
INFO: Showing help with the command 'fiatlight -- --help'.
```

**NAME**

```
fiatlight
```

**SYNOPSIS**

```
fiatlight COMMAND
```

**COMMANDS**

```
COMMAND is one of the following:
```

```
types
```

```
    List registered types, with a possible query to filter them. Add an optional
```

```
gui
```

```
    Print the info and fiat attributes available for a given type. Add the datat
```

```
fn_attrs
```

```
    Display the available fiat attributes for a function
```

See the page [Tutorials/fiatlight command line utility](#) for more information.

## Primitive types

The primitive types `int`, `float`, `str`, `bool` are registered by default.

## Basic example

```
import fiatlight as fl
def foo(a: float, b: float = 3.0, times_two: bool = False) -> float:
    return (a + b) * (2 if times_two else 1)

# Run an app that displays the GUI for the function
# where the user can input the values of the parameters
# (or use the default values)
fl.run(foo, app_name="Primitive Basic")
```



## Example with custom GUI options

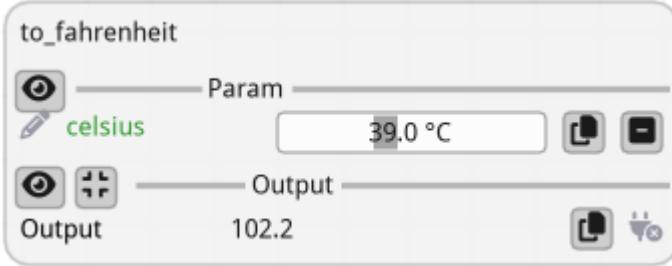
The GUI of primitive is extensively configurable via fiat attributes.

See [FunctionWithGui](#) for a comprehensive list of all the available attributes (in the "Customizing parameters GUI" section).

```
import fiatlight as fl

@fl.with_fiat_attributes(celsius_range=(0, 100), celsius_format=".1f °C")
def to_fahrenheit(celsius: float) -> float:
    return celsius * 9 / 5 + 32

fl.run(to_fahrenheit, app_name="Primitive Custom")
```



## Range limited numeric types

As a convenience, Fiatlight includes those predefined types for which the GUI will take into account their boundings.

```
from typing import NewType

# Float types with specific ranges (bounds included)
Float_0_1 = NewType("Float_0_1", float) # 0 to 1
Float_0_1.__doc__ = "synonym for float in [0, 1] (NewType)"

Float_-1_1 = NewType("Float_-1_1", float) # -1 to 1
Float_-1_1.__doc__ = "synonym for float in [-1, 1] (NewType)"

PositiveFloat = NewType("PositiveFloat", float) # Any positive float ( strictly greater than 0 )
PositiveFloat.__doc__ = "synonym for float > 0 (strictly greater than 0) (NewType)"

# Int types with specific ranges (bounds included)
Int_0_255 = NewType("Int_0_255", int) # 0 to 255
Int_0_255.__doc__ = "synonym for int in [0, 255] (NewType)"
```

## File name types

Several file types names are registered by default. They are synonyms for `str` and are used to specify file paths. They will be presented with a file dialog in the GUI.

```
from fiatlight.fiat_notebook import look_at_code
%look_at_python_code fiatlight.fiat_types.file_types
```

```
from typing import NewType

# FilePath is a synonym of str, but when used as a function parameter,
# it will be displayed as a widget where you can select a file.
FilePath = NewType("FilePath", str)
FilePath.__doc__ = "synonym for str, describing a file path (NewType)"
# FilePath_Save is a synonym of str, but when used as a function parameter,
# it will be displayed as a widget where you can select a file to save to.
FilePath_Save = NewType("FilePath_Save", str)
FilePath_Save.__doc__ = "synonym for str, describing a file path for saving (NewType)

# With ImagePath, you can select an image file.
ImagePath = NewType("ImagePath", FilePath)
ImagePath.__doc__ = "synonym for str, describing an image file path (NewType)"
ImagePath_Save = NewType("ImagePath_Save", FilePath_Save)
ImagePath_Save.__doc__ = "synonym for str, describing an image file path for saving

# With TextPath, you can select a text file.
TextPath = NewType("TextPath", FilePath)
TextPath.__doc__ = "synonym for str, describing a text file path (NewType)"
TextPath_Save = NewType("TextPath_Save", FilePath_Save)
TextPath_Save.__doc__ = "synonym for str, describing a text file path for saving (NewType)

# With AudioPath, you can select an audio file.
AudioPath = NewType("AudioPath", FilePath)
AudioPath.__doc__ = "synonym for str, describing an audio file path (NewType)"
AudioPath_Save = NewType("AudioPath_Save", FilePath_Save)
AudioPath_Save.__doc__ = "synonym for str, describing an audio file path for saving

# With VideoPath, you can select a video file.
VideoPath = NewType("VideoPath", FilePath)
VideoPath.__doc__ = "synonym for str, describing a video file path (NewType)"
VideoPath_Save = NewType("VideoPath_Save", FilePath_Save)
VideoPath_Save.__doc__ = "synonym for str, describing a video file path for saving (NewType)
```

*Example: a pipeline that lets the user select a text file and saves it into another file in lowercase*

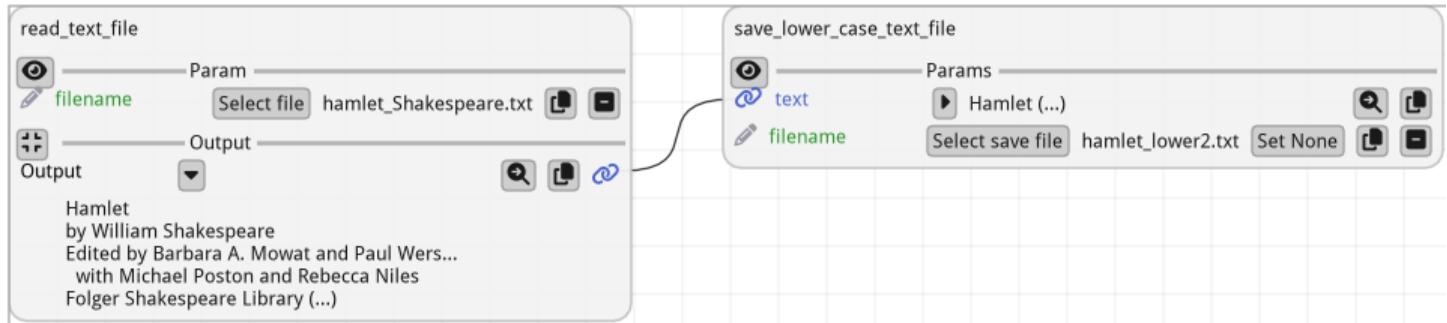
```

import fiatlight as fl
from fiatlight.fiat_types import TextPath, TextPath_Save

def read_text_file(filename: TextPath) -> str:
    with open(filename) as f:
        return f.read()

def save_lower_case_text_file(text: str, filename: TextPath_Save | None = None) -> None:
    # since filename is optional, the file will be saved only if the user selects a value
    if filename is None:
        return
    with open(filename, "w") as f:
        f.write(text.lower())

```



## Color types

Several color types are registered by default.

```
%look_at_python_code fiatlight.fiat_types.color_types
```

```

from typing import NewType

ColorRgb = NewType("ColorRgb", tuple[int, int, int])
ColorRgb.__doc__ = "synonym for tuple[int, int, int] describing an RGB color, with \n\n"
ColorRgba = NewType("ColorRgba", tuple[int, int, int, int])
ColorRgba.__doc__ = "synonym for tuple[int, int, int, int] describing an RGBA color,\n\n"
ColorRgbFloat = NewType("ColorRgbFloat", tuple[float, float, float])
ColorRgbFloat.__doc__ = (
    "synonym for tuple[float, float, float] describing an RGB color, with values in\n")
ColorRgbaFloat = NewType("ColorRgbaFloat", tuple[float, float, float, float])
ColorRgbaFloat.__doc__ = (
    "synonym for tuple[float, float, float, float] describing an RGBA color, with va\n")

def _int255_to_float(value: int) -> float:
    return value / 255.0

def _float_to_int255(value: float) -> int:
    return int(value * 255)

def color_rgb_to_color_rgb_float(color_rgb: ColorRgb) -> ColorRgbFloat:
    return ColorRgbFloat(tuple(_int255_to_float(value) for value in color_rgb)) # 1

def color_rgba_to_color_rgba_float(color_rgba: ColorRgba) -> ColorRgbaFloat:
    return ColorRgbaFloat(tuple(_int255_to_float(value) for value in color_rgba)) # 2

def color_rgb_float_to_color_rgb(color_rgb_float: ColorRgbFloat) -> ColorRgb:
    return ColorRgb(tuple(_float_to_int255(value) for value in color_rgb_float)) # 3

def color_rgba_float_to_color_rgba(color_rgba_float: ColorRgbaFloat) -> ColorRgba:
    return ColorRgba(tuple(_float_to_int255(value) for value in color_rgba_float)) # 4

def color_rgb_to_color_rgba(color_rgb: ColorRgb) -> ColorRgba:
    return ColorRgba(color_rgb + (255,))

def color_rgb_float_to_color_rgba_float(color_rgb_float: ColorRgbFloat) -> ColorRgbaFloat:
    return ColorRgbaFloat(color_rgb_float + (1.0,))

```

*Example: using color types in function*

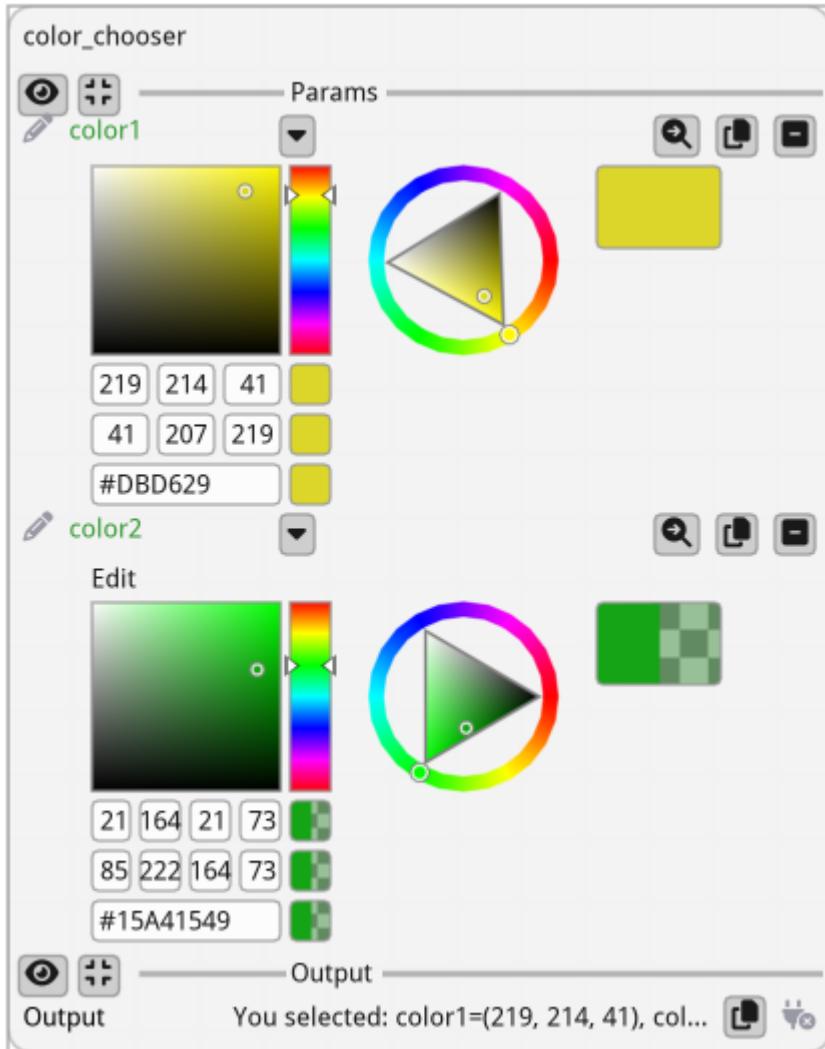
```

import fiatlight as fl
from fiatlight.fiat_types import ColorRgb, ColorRgba

def color_chooser(color1: ColorRgb, color2: ColorRgba) -> str:
    return f"You selected: {color1=}, {color2=}"

fl.run(color_chooser, app_name="Color Chooser")

```



## Optional types

If a type is registered, its optional version is also registered.

*Example: using an optional color in a function*

(In this example, the user needs to click on "Set" to set a value to the optional color)

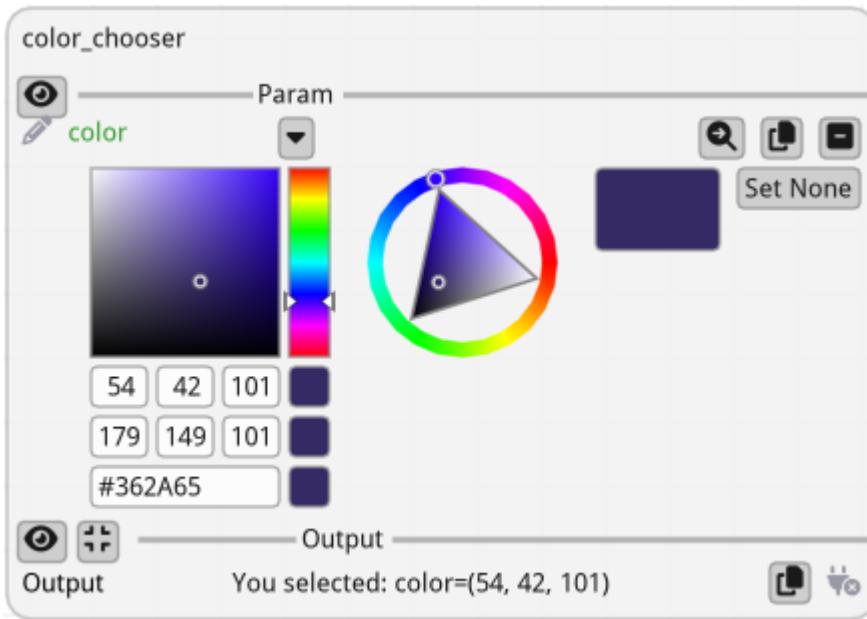
```

import fiatlight as fl
from fiatlight.fiat_types import ColorRgb, ColorRgba

def color_chooser(color: ColorRgb | None = None) -> str:
    return f"You selected: {color}"

fl.run(color_chooser, app_name="Optional Color")

```



## Lists

A very basic support is provided for lists. It does not allow to edit the values. However, it can present a list of values using (all of them will be rendered as string using str() function).

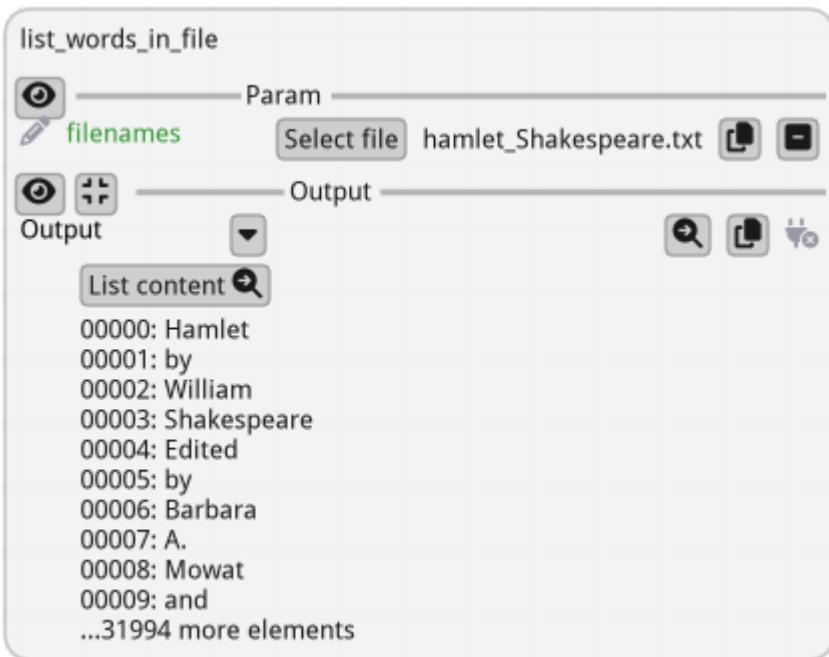
```

import fiatlight as fl
from fiatlight.fiat_types import TextPath

def list_words_in_file(filenames: TextPath) -> list[str]:
    with open(filenames) as f:
        return f.read().split()

fl.run(list_words_in_file, app_name="List Words in File")

```



## Enum classes

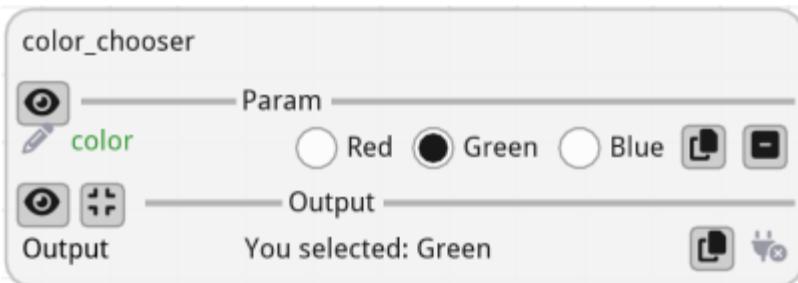
Enum classes are automatically associated to a GUI.

```
import flatlight as fl
from enum import Enum

class Color(Enum):
    Red = 1
    Green = 2
    Blue = 3

def color_chooser(color: Color) -> str:
    return f"You selected: {color.name}"

fl.run(color_chooser, app_name="Enum Color")
```



# Customizing Widgets with Fiat Attributes

## Introduction

Fiat attributes allow you to customize various aspects of the GUI for function nodes, dataclasses, and pydantic models. They provide a powerful way to modify the appearance and behavior of function parameters and outputs, adjust the GUI for dataclasses, control how function nodes run (e.g., asynchronously or manually), set labels and tooltips for function nodes and parameters, and validate function parameters and dataclass fields.

There are two main ways to add attributes to a function:

- using a decorator: `@fl.with_fiat_attributes` on top of the function definition
- using the `fl.add_fiat_attributes` function elsewhere in the code

For more details on customizing dataclasses and pydantic models, see the [GUI Registry documentation](#).

## Why Customize Widgets?

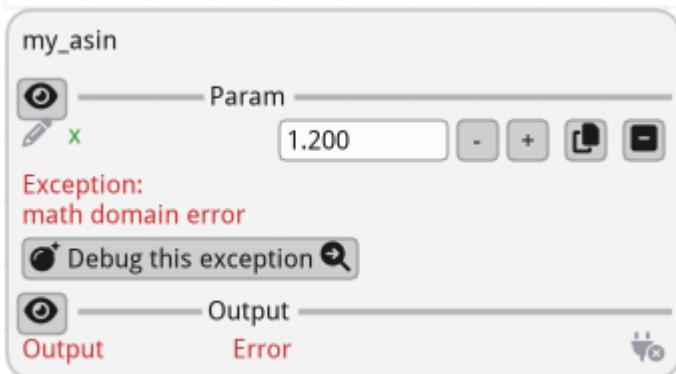
As an example, let's consider the function "my\_asin" below: if you run this function with `run()`, the GUI will allow the user to enter any float value for x. This lets the user enter values that may not be valid for the function.

```
import fiatlight as fl

# Ideally, we would like to restrict the range of x to [-1, 1]
def my_asin(x: float = 0.5) -> float:
    import math
    return math.asin(x)

fl.run(my_asin, app_name="No range restriction")
```

```
2024-07-05 00:30:13.792 Python[93667:11739238] ApplePersistenceIgnoreState: Existing
```



## Adding Attributes with a Decorator

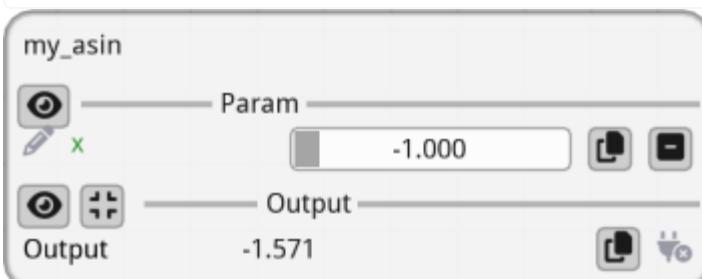
It is possible to customize the GUI for parameters using function attributes: below, we set the range for `x`. As a consequence it will be displayed with a slider widget with a range from -1 to 1.

```
import fiatlight as fl

# Use the `with_fiat_attributes` decorator to set custom fiat attributes for the fu
# Here, we set the range of the x parameter.
# Important: note the double underscore ("__") after the parameter name!
@fl.with_fiat_attributes(x__range=(-1, 1))
def my_asin(x: float = 0.5) -> float:
    import math
    return math.asin(x)

fl.run(my_asin, app_name="Range restriction")
```

```
2024-07-05 00:30:20.573 Python[93667:11739238] WARNING: Secure coding is not enabled
```



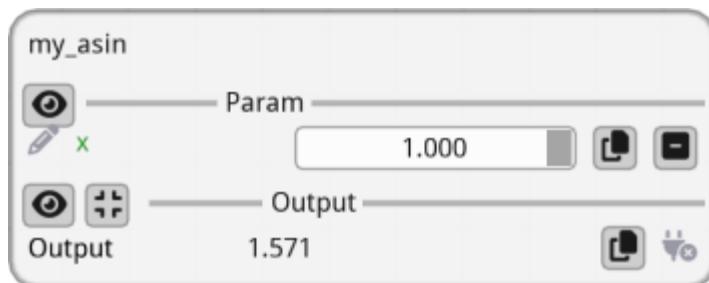
## Adding Attributes Manually

If you do not wish or cannot modify the function definition, you can use the `add_fiat_attributes` function to add attributes to the function. This way, your function stays unmodified, and you can specify the attributes only when creating its GUI.

```
import fiatlight as fl

def my_asin(x: float = 0.5) -> float:
    import math
    return math.asin(x)

# Important: note the double underscore ("__") after the parameter name!
fl.add_fiat_attributes(my_asin, x__range=(-1, 1))
fl.run(my_asin, app_name="Range restriction")
```



## Listing Available Fiat Attributes

To customize the GUI for function parameters or outputs, you can list the available fiat attributes for a specific type using the Fiatlight command line utility.

Use the command `fiatlight gui int` in a terminal (or console) to list available fiat attributes for the `int` type. For other types, replace `int` with the type you are interested in.

For more information, see "[Fiatlight command line utility](#)".

Below is an extract of the output of `fiatlight gui int`:

```

GUI type: int
=====
A highly customizable int widget.
Available fiat attributes for IntWithGui:
+-----+-----+-----+
| Name          | Type           | Default   | Explanation
+-----+-----+-----+
| range         | tuple[int, int] | (0, 10)    | Range of the integer
+-----+-----+-----+
| edit_type     | str            | input      | Type of the edit widget. Possible
|                   |                 |             | slider, input, drag, knob,
|                   |                 |             | slider_and_minus_plus
+-----+-----+-----+
| format        | str            | %d         | Format string for the value
+-----+-----+-----+
| ...           | ...            |             |

```

Available fiat attributes for AnyDataWithGui Generic attributes:

```

+-----+-----+-----+
| Name      | Type       | Default           | Explanation
+-----+-----+-----+
| label     | str        |                   | A label for the parameter. If empty,
|                   |             |                   | function parameter name is used
+-----+-----+-----+
| validator | object     | None              | Function to validate a parameter value.
|                   |             |                   | raise a ValueError if invalid, or re-
|                   |             |                   | value (possibly modified)
+-----+-----+-----+
| ...       | ...        |                   |

```

## Example: Fiat Attributes in Action

In the example below, we customize the GUI for the function `interactive_histogram` by setting fiat attributes for the number of data points, the number of bars, the mean, and the standard deviation.

```
import fiatlight
from matplotlib.figure import Figure

@fiatlight.with_fiat_attributes(
    # Label displayed as the title of the function node
    label="Interactive histogram",

    # Edit the number of data points with a logarithmic slider
    # Note: by default, you can ctrl+click on a slider to input a value directly,
    #       this is disabled here with nb_data_slider_no_input
    nb_data_label="Nb data",
    nb_data_edit_type="slider",
    nb_data_range=(100, 1_000_000),
    nb_data_slider_logarithmic=True,
    nb_data_slider_no_input=True,

    # Edit the number of bars with a knob
    n_bars_label="Number of bars",
    n_bars_edit_type="drag",
    n_bars_range=(1, 300),

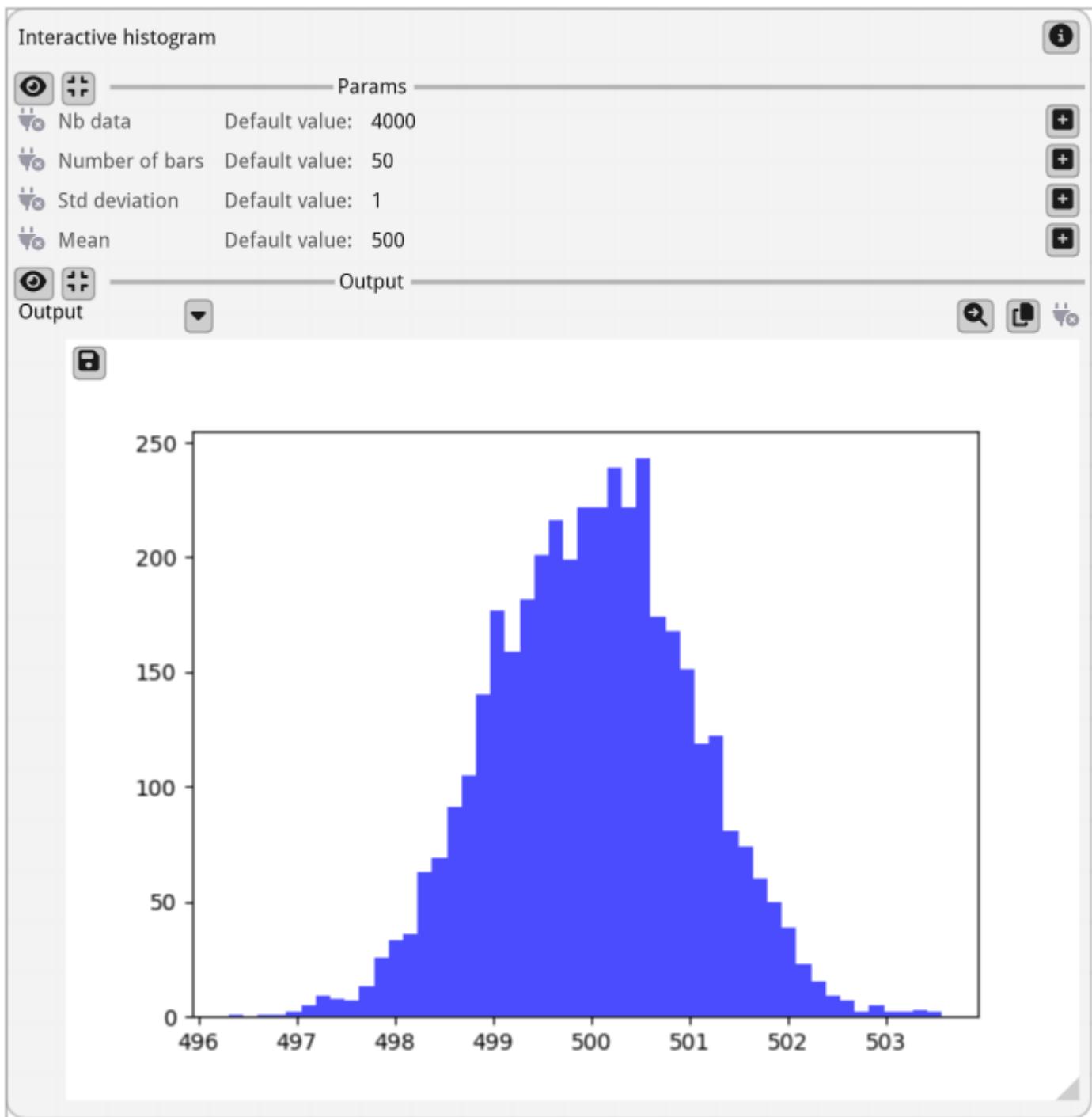
    # Edit the average with a slider for a float value with any range
    # (the slider range will adapt interactively, when dragging far to the left or
    average_label="Mean",
    average_edit_type="slider_float_any_range",
    average_range=(-5, 5),

    # Edit the standard deviation with a drag
    sigma_label="Std deviation",
    sigma_edit_type="knob",
    sigma_range=(0.1, 5),

)
def interactive_histogram(
    nb_data: int = 4000, n_bars: int = 50, sigma: float = 1, average: float = 500
) -> Figure:
    '''Generate an interactive histogram with adjustable number of bars, mean, and
    import numpy as np
    import matplotlib.pyplot as plt

    data = np.random.normal(loc=average, scale=sigma, size=nb_data)
    bins = np.linspace(np.min(data), np.max(data), n_bars)
    fig, ax = plt.subplots()
    ax.hist(data, bins=bins, color="blue", alpha=0.7)
    return fig

    fiatlight.run(interactive_histogram, app_name="Fiat attributes")
```



## Fiatlight command line utility

The `fiatlight` command line utility is a powerful tool that allows you to explore the available widgets and types in Fiatlight. It can be used to list the available types, to print the GUI info for a given type, and to run a GUI demo for a given type.

Here is the help message for the `fiatlight` command line utility (ignore the `%%bash` magic command, it is used to run bash commands in Jupyter notebooks):

```
%%bash
fiatlight --help
```

INFO: Showing help with the command 'fiatlight -- --help'.

**NAME**

fiatlight

**SYNOPSIS**

fiatlight COMMAND

**COMMANDS**

COMMAND is one of the following:

types

List registered types, with a possible query to filter them. Add an optional

gui

Print the GUI info for a given type. Add the GUI type name as an argument (i·

## List registered types

The `types` command lists the registered types in Fiatlight. You can filter the types by adding an optional query.

In the example below, we will run the `fiatlight types str` command to list all the types that contain the string "str".

```
%%bash
fiatlight types str
```



Data Type	Gui Type
str	flatlight.flat_togui.str_with_multiline_editing. A Gui for a string with re-multiline editing.
flatlight.flat_types.flat_number_types.PositiveFloat at synonym for float > 0 (strictly greater than 0) (NewType)	flatlight.flat_togui.primitive. A highly customizable float
flatlight.flat_types.file_types.FilePath synonym for str, describing a file path (NewType)	flatlight.flat_togui.file_type. A Gui that enable to selec-
flatlight.flat_types.file_types.TextPath synonym for str, describing a text file path (NewType)	flatlight.flat_togui.file_type. A Gui that enable to selec-
flatlight.flat_types.file_types.ImagePath synonym for str, describing an image file path (NewType)	flatlight.flat_togui.file_type. A Gui that enable to selec-
flatlight.flat_types.file_types.AudioPath synonym for str, describing an audio file path (NewType)	flatlight.flat_togui.file_type. A Gui that enable to selec-
flatlight.flat_types.file_types.VideoPath synonym for str, describing a video file path (NewType)	flatlight.flat_togui.file_type. A Gui that enable to selec-
flatlight.flat_types.file_types.FilePath_Save synonym for str, describing a file path for saving (NewType)	flatlight.flat_togui.file_type. A Gui that enable to selec- dialog.
flatlight.flat_types.file_types.TextPath_Save synonym for str, describing a text file path for saving (NewType)	flatlight.flat_togui.file_type. A Gui that enable to selec- file dialog.
flatlight.flat_types.file_types.ImagePath_Save synonym for str, describing an image file path for saving (NewType)	flatlight.flat_togui.file_type. A Gui that enable to selec- file dialog.
flatlight.flat_types.file_types.AudioPath_Save synonym for str, describing an audio file path for saving (NewType)	flatlight.flat_togui.file_type. A Gui that enable to selec- file dialog.
flatlight.flat_types.file_types.VideoPath_Save synonym for str, describing a video file path for saving (NewType)	flatlight.flat_togui.file_type. A Gui that enable to selec- file dialog.
flatlight.flat_kits.flat_ai.prompt.Prompt	flatlight.flat_kits.flat_ai.

```
| synonym for a string used as a prompt, used for | A Gui to edit a prompt, wi  
| AI text and image generation models (NewType) | in a popup.  
+-----+
```

Notes:

- If you do not include the `str` argument, all the types will be printed.

## Print the GUI info for a given type

The `gui_info` command prints the GUI info for a given type. You can specify the GUI type name or the data type name as an argument. If you do not provide a type name, all the GUI widget names will be printed.

### Example: Print the GUI info for StrWithGui

In the example below, we will run the `fiatlight gui_info StrWithGui` command to print the GUI info for the `StrWithGui` widget.

```
%%bash  
fiatlight gui str
```



GUI type: str

=====

A Gui for a string with resizable input text, with a popup for multiline editing.

Available custom attributes for StrWithGui:

Name	Type	Default	Explanation
width_em	float	15.0	Initial width of the (in em unit). Can be True
size_multiline_em	tuple[float, float]	(60.0, 15.0)	Initial size of the em unit)
hint	str		Hint text for the input
allow_multiline_edit	bool	False	Whether the user can edit a multiline string (will open a modal)
resizable	bool	True	Whether the single line input is resizable
wrap_multiline	bool	False	Whether the text is presented as a multiline string
wrap_multiline_width	int	80	Width at which the text is presented as a multiline string

Available custom attributes for AnyDataWithGui Generic attributes:

Name	Type	Default	Explanation
			**Generic attributes**
validate_value	object	None	Function to validate a parameter. If None, return DataValidationResult.ok()
label	str		A label for the parameter. If empty, the function parameter name is used
tooltip	str		An optional tooltip to be displayed
label_color	ImVec4	ImVec4(0.000000, 0.000000, 0.000000, 1.000000)	The color of the label (will use text color if not provided)

Code to test this GUI type:

```
```python
```

```
import typing
import fiatlight

@fiatlight.with_fiat_attributes(
    str_param_width_em = 15.0,
    str_param_size_multiline_em = (60.0, 15.0),
    str_param_hint = "",
    str_param_allow_multiline_edit = False,
    str_param_resizable = True,
    str_param_wrap_multiline = False,
    str_param_wrap_multiline_width = 80,
    # Generic attributes
    str_param_validate_value = None,
    str_param_label = "",
    str_param_tooltip = "",
    str_param_label_color = ImVec4(0.000000, 0.000000, 0.000000, 1.000000))
def f(str_param: str) -> str:
    return str_param

fiatlight.run(f)
```
```

## Example: Print the GUI info for ImageWithGui

```
%%bash
fiatlight gui ImageWithGui
```



GUI type: ImageWithGui

=====

A highly sophisticated GUI for displaying and analysing images. Zoom/Pan, show ch

Available custom attributes for fiat\_image.ImageWithGui:

| Name                            | Type            | Default  | Explanation   |
|---------------------------------|-----------------|----------|---|
| **Main attributes**             |                 |          |   |
| only_display                    | bool            | False    | Only display the zoom, no pan                       |
| Initial size of height). One of |                 |          |   |
| image_display_size              | tuple[int, int] | (200, 0) |   |
| zoom_key                        | str             | z        | Key to zoom in same zoom key w                      |
| is_color_order_bgr              | bool            | True     | Color order is BGR by default                       |
| can_resize                      | bool            | True     | Can resize the image with the bottom right corner   |
| **Channels**                    |                 |          |   |
| show_channels                   | bool            | False    | Show channels                                       |
| channel_layout_vertically       | bool            | False    | Layout channels vertically                          |
| **Zoom & Pan**                  |                 |          |   |
| pan_with_mouse                  | bool            | True     | Pan with mouse                                      |
| zoom_with_mouse_wheel           | bool            | True     | Zoom with mouse wheel                               |
| **Info displayed**              |                 |          |   |
| show_school_paper_background    | bool            | True     | Show school paper background when image is unzoomed |
| show_alpha_channel_checkerboard | bool            | True     | Show alpha channel checkerboard                     |
| show_grid                       | bool            | True     | Show grid with image                                |
| draw_values_on_zoomed_pixels    | bool            | True     | Draw values on zoomed pixels                        |
| **Info displayed**              |                 |          |   |
| show_image_info                 | bool            | True     | Show image info                                     |

|                           |                           |                           |                                  |
|---------------------------|---------------------------|---------------------------|----------------------------------|
| show_pixel_info           | bool                      | True                      | Show pixel info position under   |
|                           |                           |                           | **Control button**               |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+        |
| show_zoom_buttons         | bool                      | True                      | Show zoom buttons                |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+        |
| show_options_panel        | bool                      | True                      | Show options panel               |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+        |
| show_options_button       | bool                      | True                      | Show options button              |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+        |
| show_inspect_button       | bool                      | True                      | Show the inspect button          |
|                           |                           |                           | a large version of the Inspector |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+        |

Available custom attributes for AnyDataWithGui Generic attributes:

| Name                      | Type                      | Default  | Explanation   |
|---------------------------|---------------------------|--|---|
|                           |                           |  | **Generic attributes**  |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+                      | +-----+-----+-----+-----+   |
| validate_value            | object                    | None   | Function to validate a parameter. If None, return DataValidationResult.ok() |
|                           |                           |  |   |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+                      | +-----+-----+-----+-----+   |
| label                     | str                       |  | A label for the parameter. If empty, function parameter name is used        |
|                           |                           |  |   |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+                      | +-----+-----+-----+-----+   |
| tooltip                   | str                       |  | An optional tooltip to be displayed   |
|                           |                           |  |   |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+                      | +-----+-----+-----+-----+   |
| label_color               | ImVec4                    | ImVec4(0.000000, 0.000000, 0.000000, 1.000000) | The color of the label (will use text color if not provided)                |
|                           |                           |  |   |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+                      | +-----+-----+-----+-----+   |

Code to test this GUI type:

```
```python
import typing
import fiatlight

@fiatlight.with_fiat_attributes(
    # Main attributes for the image viewer
    union_param_only_display = False,
    union_param_image_display_size = (200, 0),
    union_param_zoom_key = "z",
    union_param_is_color_order_bgr = True,
    union_param_can_resize = True,
    # Channels
    union_param_show_channels = False,
    union_param_channel_layout_vertically = False,
    # Zoom & Pan
    union_param_pan_with_mouse = True,
```

```

union_param__zoom_with_mouse_wheel = True,
# Info displayed on image
union_param__show_school_paper_background = True,
union_param__show_alpha_channel_checkerboard = True,
union_param__show_grid = True,
union_param__draw_values_on_zoomed_pixels = True,
# Info displayed under the image
union_param__show_image_info = True,
union_param__show_pixel_info = True,
# Control buttons under the image
union_param__show_zoom_buttons = True,
union_param__show_options_panel = True,
union_param__show_options_button = True,
union_param__show_inspect_button = True,
# Generic attributes
union_param__validate_value = None,
union_param__label = "",
union_param__tooltip = "",
union_param__label_color = ImVec4(0.000000, 0.000000, 0.000000, 1.000000)
def f(union_param: typing.Union[flatlight.flat_kits.flat_image.image_types.ImageU8_]:
    return union_param

flatlight.run(f)
```

```

## Annex: list of registered types

By running the `flatlight types` command, you can list all the registered types in Fiatlight. Here is a list of the available types:

```
%%bash
flatlight types
```



| Data Type  | Gui Type   |
|--|--|
| fiatlight.fiat_types.fiat_number_types.Float_0_1<br>  synonym for float in [0, 1] (NewType)  | fiatlight.fiat_togui.primitive<br>  A highly customizable float                              |
| fiatlight.fiat_types.fiat_number_types.Float_-1_1<br>  synonym for float in [-1, 1] (NewType)  | fiatlight.fiat_togui.primitive<br>  A highly customizable float                              |
| fiatlight.fiat_types.fiat_number_types.Int_0_255<br>  synonym for int in [0, 255] (NewType)  | fiatlight.fiat_togui.primitive<br>  A highly customizable int                                |
| int  | fiatlight.fiat_togui.primitive<br>  A highly customizable int                                |
| float  | fiatlight.fiat_togui.primitive<br>  A highly customizable float                              |
| str  | fiatlight.fiat_togui.str_with_multiline<br>  A Gui for a string with<br>  multiline editing. |
| bool   | fiatlight.fiat_togui.primitive<br>  A bool widget. Can use a cl                              |
| fiatlight.fiat_types.color_types.ColorRgb<br>  synonym for tuple[int, int, int] describing an<br>  RGB color, with values in [0, 255] (NewType)                      | fiatlight.fiat_togui.primitive<br>  A nice color picker for RGB                              |
| fiatlight.fiat_types.color_types.ColorRgba<br>  synonym for tuple[int, int, int, int] describing<br>  an RGBA color, with values in [0, 255] (NewType)               | fiatlight.fiat_togui.primitive<br>  A nice color picker for RGBA                             |
| fiatlight.fiat_types.color_types.ColorRgbFloat<br>  synonym for tuple[float, float, float]<br>  describing an RGB color, with values in [0, 1]<br>(NewType)          | fiatlight.fiat_togui.primitive<br>  A nice color picker for RGB                              |
| fiatlight.fiat_types.color_types.ColorRgbaFloat<br>  synonym for tuple[float, float, float, float]<br>  describing an RGBA color, with values in [0, 1]<br>(NewType) | fiatlight.fiat_togui.primitive<br>  A nice color picker for RGBA                             |
| fiatlight.fiat_types.fiat_number_types.PositiveFloat<br>  synonym for float > 0 (strictly greater than 0)<br>(NewType)   | fiatlight.fiat_togui.primitive<br>  A highly customizable float                              |
| (dataclass) fiatlight.fiat_togui.dataclass_example<br>  s.ExampleDataclass<br>  ExampleDataclass(x: int = 0, y: str = 'Hello')                                       | fiatlight.fiat_togui.dataclass<br>  A sophisticated GUI for a c                              |
| (BaseModel) fiatlight.fiat_togui.dataclass_example   | fiatlight.fiat_togui.basemodel   |

|  |  |
|--|--|
| s.ExampleBaseModel   | A sophisticated GUI for a  |
| fiatlight.fiat_types.file_types.FilePath<br>  synonym for str, describing a file path<br>  (NewType)   | fiatlight.fiat_togui.file_ty<br>  A Gui that enable to selec                   |
| fiatlight.fiat_types.file_types.TextPath<br>  synonym for str, describing a text file path<br>  (NewType)  | fiatlight.fiat_togui.file_ty<br>  A Gui that enable to selec                   |
| fiatlight.fiat_types.file_types.ImagePath<br>  synonym for str, describing an image file path<br>  (NewType)   | fiatlight.fiat_togui.file_ty<br>  A Gui that enable to selec                   |
| fiatlight.fiat_types.file_types.AudioPath<br>  synonym for str, describing an audio file path<br>  (NewType)   | fiatlight.fiat_togui.file_ty<br>  A Gui that enable to selec                   |
| fiatlight.fiat_types.file_types.VideoPath<br>  synonym for str, describing a video file path<br>  (NewType)  | fiatlight.fiat_togui.file_ty<br>  A Gui that enable to selec                   |
| fiatlight.fiat_types.file_types.FilePath_Save<br>  synonym for str, describing a file path for<br>  saving (NewType)   | fiatlight.fiat_togui.file_ty<br>  A Gui that enable to selec<br>  dialog.      |
| fiatlight.fiat_types.file_types.TextPath_Save<br>  synonym for str, describing a text file path for<br>  saving (NewType)  | fiatlight.fiat_togui.file_ty<br>  A Gui that enable to selec<br>  file dialog. |
| fiatlight.fiat_types.file_types.ImagePath_Save<br>  synonym for str, describing an image file path<br>  for saving (NewType)   | fiatlight.fiat_togui.file_ty<br>  A Gui that enable to selec<br>  file dialog. |
| fiatlight.fiat_types.file_types.AudioPath_Save<br>  synonym for str, describing an audio file path<br>  for saving (NewType)   | fiatlight.fiat_togui.file_ty<br>  A Gui that enable to selec<br>  file dialog. |
| fiatlight.fiat_types.file_types.VideoPath_Save<br>  synonym for str, describing a video file path<br>  for saving (NewType)  | fiatlight.fiat_togui.file_ty<br>  A Gui that enable to selec<br>  file dialog. |
| (BaseModel) fiatlight.fiat_kits.fiat_image.cv_color_type.ColorConversion<br>  A color conversion from one color space to<br>  another (color spaces use the ColorType enum). | fiatlight.fiat_togui.basemode<br>  A sophisticated GUI for a                   |
| (BaseModel) fiatlight.fiat_kits.fiat_image.lut_types.ColorLutParams  | fiatlight.fiat_togui.basemode<br>  A sophisticated GUI for a                   |
| (BaseModel) fiatlight.fiat_kits.fiat_image.camera_image_provider.CameraParams<br>  Parameters for the camera image provider  | fiatlight.fiat_togui.basemode<br>  A sophisticated GUI for a                   |

|  |  |
|--|--|
| None   | fiatlight.fiat_kits.fiat_image   |
| All types whose name starts with<br>  fiatlight.fiat_kits.fiat_image.image_types.Image             | A highly sophisticated GUI<br>Zoom/Pan, show channels, show<br>etc.          |
| +-----   | +-----   |
| None   | fiatlight.fiat_kits.fiat_image   |
| Union of types whose name starts with<br>  fiatlight.fiat_kits.fiat_image.image_types.Image        | A highly sophisticated GUI<br>Zoom/Pan, show channels, show<br>etc.          |
| +-----   | +-----   |
| (BaseModel)  | fiatlight.fiat_kits.fiat_image   |
| fiatlight.fiat_kits.fiat_image.lut_types.LutParams   | A GUI for LutParams, allow<br>Look-Up Table transformation                   |
| Simple parameters to create a LUT (Look-Up<br>Table) transformation to an image                    |  |
| +-----   | +-----   |
| fiatlight.fiat_kits.fiat_implot.array_types.FloatM<br>  atrix_Dim1                                 | fiatlight.fiat_kits.fiat_implot  |
| synonym for a 1D ndarray of floats (NewType)   | A GUI for presenting 1D or<br>array as a line, scatter (+ :<br>small enough) |
| +-----   | +-----   |
| fiatlight.fiat_kits.fiat_implot.array_types.FloatM<br>  atrix_Dim2                                 | fiatlight.fiat_kits.fiat_implot  |
| synonym for a 2D ndarray of floats (NewType)   | A GUI for presenting 1D or<br>array as a line, scatter (+ :<br>small enough) |
| +-----   | +-----   |
| fiatlight.fiat_kits.fiat_ai.prompt.Prompt  | fiatlight.fiat_kits.fiat_ai.   |
| synonym for a string used as a prompt, used for<br>  AI text and image generation models (NewType) | A Gui to edit a prompt, wi<br>in a popup.                                    |
| +-----   | +-----   |
| pandas.core.frame.DataFrame  | fiatlight.fiat_kits.fiat_data  |
|  | A class to present a pandas<br>and other features. Open in a                 |
| +-----   | +-----   |
| matplotlib.figure.Figure   | fiatlight.fiat_kits.fiat_mat   |
| The top level container for all the plot<br>elements.  | A Gui that can present a re  |
| +-----   | +-----   |

## Functions Graph

**FunctionsGraph** is one of the core classes of FiatLight: it represents a graph of functions, where the output of one function can be linked to the input of another function.

- **Source:** see its full code [online](#)
- **API:** [FunctionsGraph API](#)

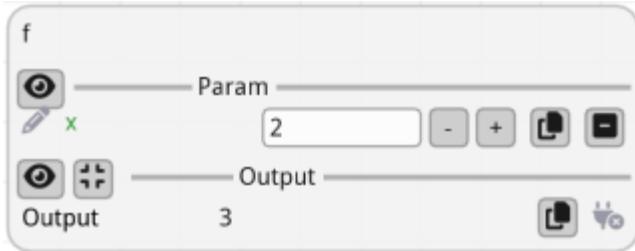
# Creating a FunctionsGraph

## When a FunctionsGraph can be created automatically

In simple cases (one function, or a list of functions that are chained together), you do not need to create a FunctionsGraph. See the examples below.

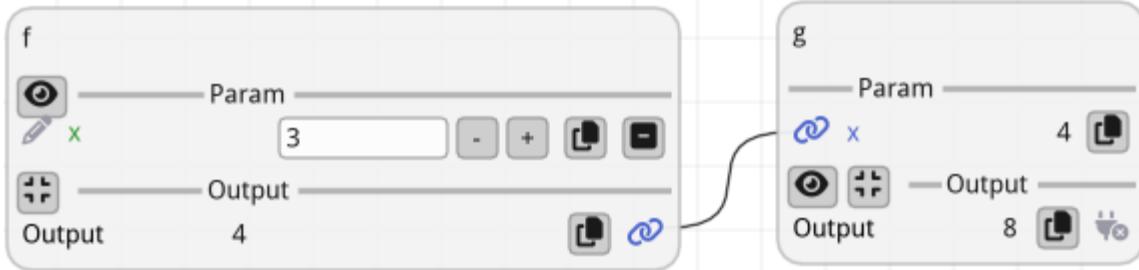
*Single function:*

```
import fiatlight as fl
def f(x: int) -> int:
    return x + 1
fl.run(f, app_name="Single function")
```



*Chained functions:*

```
import fiatlight as fl
def f(x: int) -> int:
    return x + 1
def g(x: int) -> int:
    return x * 2
fl.run([f, g], app_name="Chained functions")
```



## When you need to create a FunctionsGraph

For more complex cases, you can create a FunctionsGraph manually. This allows you to precisely control the links between the functions.

```
import fiatlight as fl

def int_source(x : int) -> int:
    """This function will be the entry point of the graph
    Since its inputs is unlinked, fiatlight will ask the user for a value for x
    """
    return x

def square(x: int) -> int:
    return x * x

def add(x: int, y: int) -> int:
    return x + y

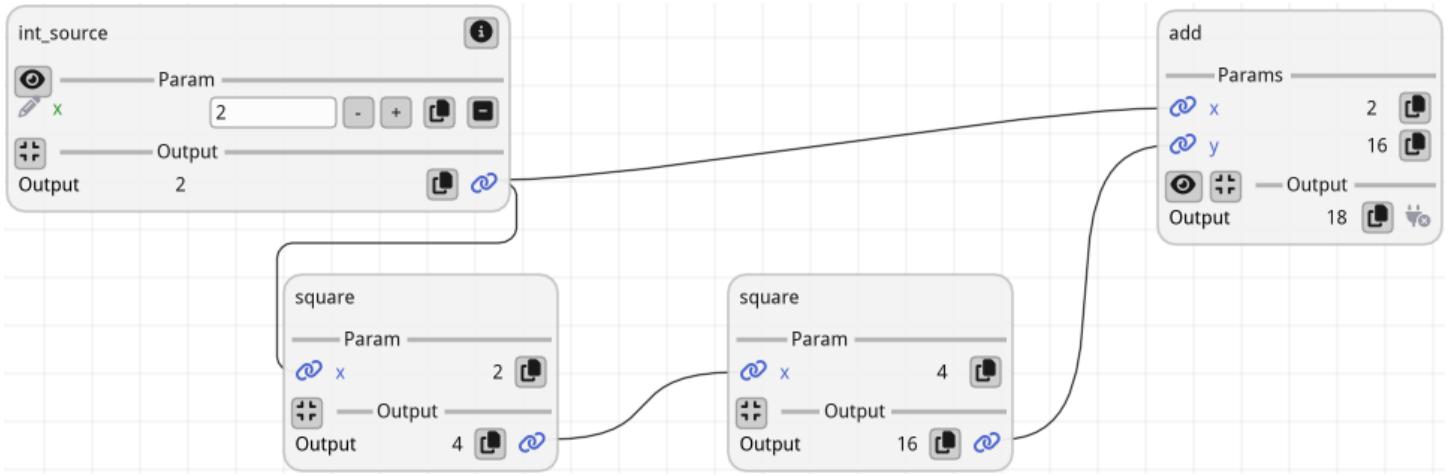
# 1. Create the graph
#
# Notes:
#     - in this example we add the function `square` *two times*!
#     - Each of them will have a different *unique name*: "square_1" and "square_2"
#     - instead of creating a graph from a function composition, we could also create
#         and add the functions manually, like show in the comment below:
#             graph = fl.FunctionsGraph.create_empty()
#             graph.add_function_composition([int_source, square, square])
#
graph = fl.FunctionsGraph.from_function_composition([int_source, square, square])

# 2. Manually add a function
graph.add_function(add)

# 3. And link it
# First, link the output of int_source to the "x" input of add
# Note: we could also specify the source output index: src_output_idx=0 (but this is
graph.add_link("int_source", "add", dst_input_name="x")

# Then, link the output of the second `square` to the "y" input of add
graph.add_link("square_2", "add", dst_input_name="y")

# 4. Run the graph
fl.run(graph, app_name="Manual graph")
```



# Validate inputs with Fiatlight

## Introduction

Validators are functions that check the validity of a parameter value and raise a `ValueError` (with a nice error message), or correct the value if it is not valid. They are a powerful tool to ensure that the user enters valid values for the function parameters.

## Example: Validators for function parameters

The code below will produce a GUI where:

- The `even_int` parameter must be an even integer. If it is not, the user will see a warning.
- The `multiple_of_5` parameter will automatically correct the input to the nearest multiple of 5.

This enhances user experience by providing immediate feedback and corrections, making the application more robust and user-friendly.

```

import fiatlight as fl

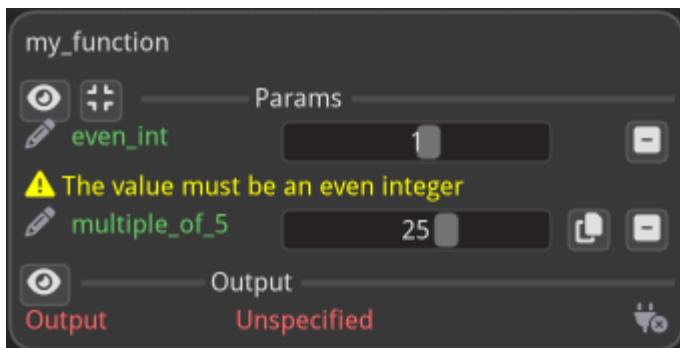
def even_int_validator(x: int) -> int:
    """This validator checks that the value is an even integer, and warns the user
    if x % 2 != 0:
        raise ValueError("The value must be an even integer")
    return x

def multiple_of_5_validator(x: int) -> int:
    """This validator will correct the user input to the closest multiple of 5."""
    return int(x / 5) * 5

def my_function(even_int: int = 0, multiple_of_5: int = 0) -> int:
    return even_int + multiple_of_5

fl.add_fiat_attributes(
    my_function,
    even_int_validator=even_int_validator,
    even_int_range=(-10, 10),
    multiple_of_5_validator=multiple_of_5_validator,
    multiple_of_5_range=(-100, 100)
)
fl.run(my_function, app_name="Validators")

```



Note: instead of using `fl.add_fiat_attributes`, you can also use the `@fl.with_fiat_attributes` decorator on top of the function to register its validators.

## Example: Validators for Dataclass members

The code below will produce the same GUI as the previous example, but this time using a dataclass.

```

import fiatlight as fl
from dataclasses import dataclass # optional, since fiatlight will add the @datacl
                                # when using the @fl.dataclass_with_gui_registration

def even_int_validator(x: int) -> int:
    """This validator checks that the value is an even integer, and warns the user
    if x % 2 != 0:
        raise ValueError("The value must be an even integer")
    return x

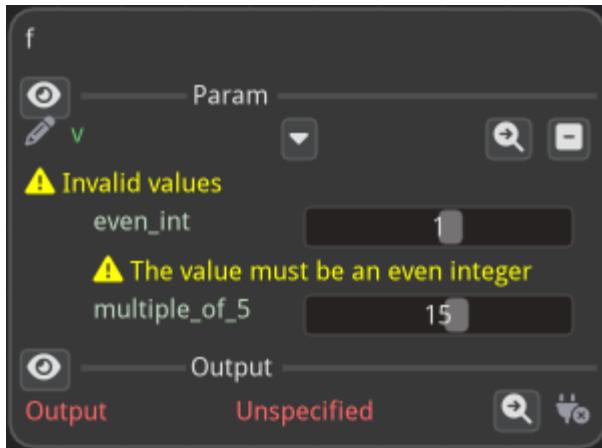
def multiple_of_5_validator(x: int) -> int:
    """This validator will correct the user input to the closest multiple of 5."""
    return int(x / 5) * 5

# Note: the decorator @fl.dataclass_with_gui_registration will also apply
#       the @dataclass decorator to the class
@fl.dataclass_with_gui_registration(
    even_int_validator=even_int_validator,
    even_int_range=(-10, 10),
    multiple_of_5_validator=multiple_of_5_validator,
    multiple_of_5_range=(-100, 100)
)
class MyData:
    even_int: int = 0
    multiple_of_5: int = 0

def f(v: MyData) -> MyData:
    return v

fl.run(f, app_name="Validators in a Dataclass")

```



Note: instead of using the decorator `@fl.dataclass_with_gui_registration` on top of the dataclass, you can also use the `the function` `fl.register_dataclass`` to register the dataclass,

and add fiat attributes, such as the validators.

## Example: Validators for BaseModel members

The code below will produce the same GUI as the previous example, but this time using a Pydantic model. In this case we can also use standard Pydantic validators.

Note: Fiatlight will also interpret the range from the less than (le) and greater than (ge) constraints in the Pydantic model.

```
import fiatlight as fl
from pydantic import BaseModel, Field, field_validator

@fl.base_model_with_gui_registration()
class MyData(BaseModel):
    even_int: int = Field(0, ge=-10, le=10)
    multiple_of_5: int = Field(0, ge=-100, le=100)

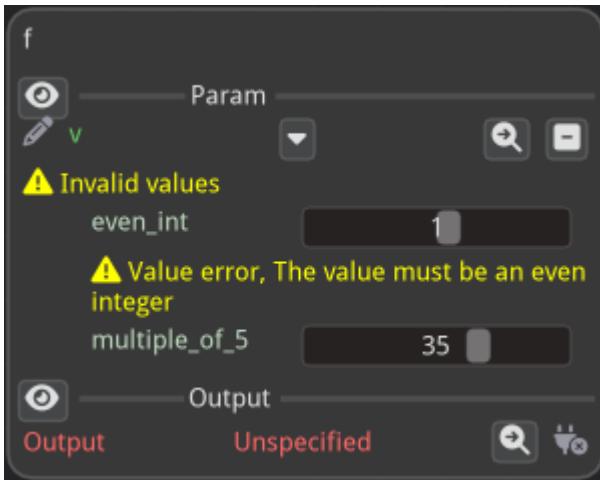
    @field_validator("even_int")
    def even_int_validator(cls, v):
        if v % 2 != 0:
            raise ValueError("The value must be an even integer")
        return v

    @field_validator("multiple_of_5")
    def multiple_of_5_validator(cls, v):
        return int(v / 5) * 5

    def f(self):
        return self

def f(v: MyData) -> MyData:
    return v

fl.run(f, app_name="Validators in a Pydantic model")
```



*Note: instead of using the decorator `@fl.base_model_with_gui_registration` on top of the Pydantic model, you can also use the `the function fl.register_base_model` to register the Pydantic model, and add fiat attributes, such as the validators.`*

## Dataclasses & Pydantic Models

### Dataclasses

Dataclasses can easily be registered with their GUI.

*Note: Fiatlight is unable to auto-generate a serialization/deserialization mechanism for dataclasses. If you need this, it is advised to use Pydantic models instead.*

*Example: using a dataclass in a function*

```

import fiatlight as fl
from dataclasses import dataclass

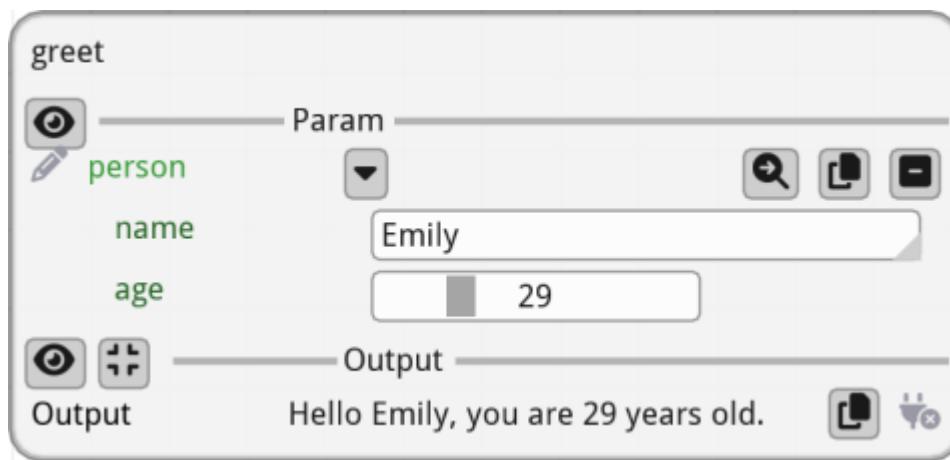
# Using a decorator to register the dataclass with its GUI
@fl.dataclass_with_gui_registration(age__range=(0, 120))
class Person:
    name: str
    age: int

# Note: it is also possible to register the dataclass with the commented line below
#     fl.register_dataclass(Person)

def greet(person: Person) -> str:
    return f"Hello {person.name}, you are {person.age} years old."

# Note: this app *will not* remember the values of the dataclass fields between runs
fl.run(greet, app_name="Dataclass Person")

```



## Pydantic models

Pydantic models can easily be registered with their GUI.

Notes:

- flatlight will automatically generate a serialization/deserialization mechanism for Pydantic models, so that user entries can be saved and reloaded.*
- models can be nested: in the example below, you will see 3 levels of nesting, and flatlight will generate a nice GUI for those nestings.*

Example: using a Pydantic model in a function

```

import fiatlight as fl
from enum import Enum
from fiatlight.fiat_types import ImagePath
from fiatlight.fiat_kits.fiat_image import ImageU8_3
from pydantic import BaseModel
import cv2

# An Enum which will be associated to a Gui automatically
class TrainingDataType(Enum):
    Test = "test"
    Train = "train"
    Validation = "validation"

# A Pydantic model with a GUI decorator, and custom fiat attributes for the fields
@fl.base_model_with_gui_registration(latitude__range=(-90, 90), longitude__range=(-180, 180))
class GeographicInfo(BaseModel):
    latitude: float
    longitude: float

# Note: it is also possible to register the Pydantic model with the commented line
#     fl.register_base_model(GeographicInfo)

# A second model, which nests the first one (GeographicInfo)
@fl.base_model_with_gui_registration(width__range=(0, 2000), height__range=(0, 2000))
class ImageInfo(BaseModel):
    geo_info: GeographicInfo
    description: str
    width: int
    height: int

# A third model, which nests the second one (ImageInfo)
# In total, it has 3 levels: TrainingImage -> ImageInfo -> GeographicInfo
@fl.base_model_with_gui_registration()
class TrainingImage(BaseModel):
    image_path: ImagePath
    data_type: TrainingDataType
    info: ImageInfo

# Our function that uses the Pydantic model:
# we ought to see a nice GUI with 3 levels of nesting
def process_image(image: TrainingImage) -> tuple[str, ImageU8_3]:
    import os
    basename = os.path.basename(image.image_path)
    img = fl.imread_rgb(image.image_path)
    return basename, img

# Note: this app *will* remember the values of the Pydantic model fields between runs
fl.run(process_image, app_name="Pydantic Image Model")

```

## process\_image

Param

image  house.jpg

image\_path  Test  Train  Validation

info

geo\_info

latitude

longitude

description

width

height

Outputs

Output 1 house.jpg

Output 2

Show channels



CV\_8UC3 1000x856 - Zoom:0.200



Inspect

# Custom types registration

By calling `fiatlight.register_type(DataType, DataTypeWithGui)`, it is possible to register a custom type with its GUI.

For a given type's GUI, it is possible to customize many aspects. Basically all the callbacks and options inside [AnyDataGuiCallbacks](#) can be customized.

## Example 1: a customizable Normal Distribution type

### Step 1: Define the Custom Type

First, let's define a new type called NormalDistribution.

```
class NormalDistribution:
    mean: float = 0.0
    stddev: float = 1.0

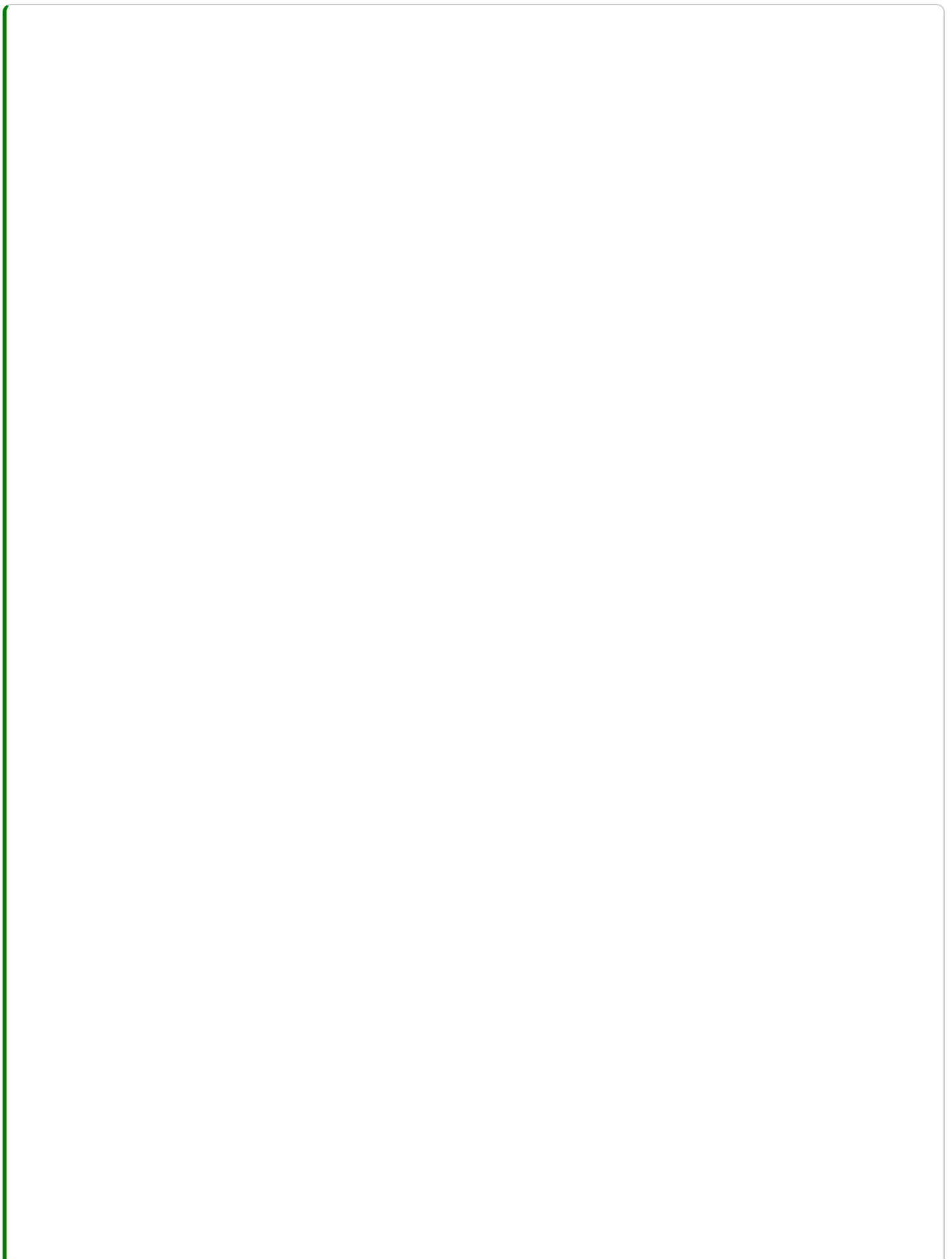
    def __init__(self, mean: float = 0.0, stddev: float = 1.0) -> None:
        self.mean = mean
        self.stddev = stddev
```

### Step 2: Create a Class to Handle the Custom Type

Next, we create a class NormalDistributionWithGui that extends AnyWithData and defines the custom presentation and editing logic for the NormalDistribution type.

It will handle:

- A custom GUI for editing the NormalDistribution type
- A custom GUI for presenting the NormalDistribution type (using a cached figure, which is updated when the distribution changes)
- Serialization and deserialization of the custom type
- A default value provider



```
import fiatlight as fl
from imgui_bundle import imgui, imgui_fig
import matplotlib.pyplot as plt
from matplotlib.figure import Figure
import numpy as np

class NormalDistributionWithGui(fl.AnyDataWithGui[NormalDistribution]):
    # Cached figure for the distribution plot
    figure: Figure | None = None
    # boolean to indicate if the figure image should be refreshed
    shall_refresh_figure_image: bool = True

    def __init__(self) -> None:
        super().__init__(NormalDistribution)

        # Edit and present callbacks
        self.callbacks.edit = self._edit_gui
        self.callbacks.present = self._present_gui
        self.callbacks.present_str = lambda value: f"Normal Distrib: Mean={value.mean:.2f}, StdDev={value.stddev:.2f}"

        # Default value provider
        self.callbacks.default_value_provider = lambda: NormalDistribution()

        # Serialization of the custom type
        # (note it would be automatic if we used a Pydantic model)
        self.callbacks.save_to_dict = lambda value: {"mean": value.mean, "stddev": value.stddev}
        self.callbacks.load_from_dict = lambda data: NormalDistribution(mean=data["mean"], stddev=data["stddev"])

        # Callback for handling changes: we need to subscribe to this event
        # in order to update the self.figure when the distribution changes
        self.callbacks.on_change = self._on_change

    def _on_change(self, value: NormalDistribution) -> None:
        # remember to close the previous figure to avoid memory leaks
        if self.figure is not None:
            plt.close(self.figure)

        # Create the figure
        x = np.linspace(value.mean - 4 * value.stddev, value.mean + 4 * value.stddev, 100)
        y = (1 / (value.stddev * np.sqrt(2 * np.pi))) * np.exp(-0.5 * ((x - value.mean) ** 2) / (value.stddev ** 2))
        figure = plt.figure(figsize=(4, 3))
        plt.plot(x, y)
        plt.title("Normal Distribution")
        plt.xlabel("x")
        plt.ylabel("Density")
        plt.grid(True)

        # Cache the figure
        self.figure = figure

        # Indicate that the figure image should be refreshed
        self.shall_refresh_figure_image = True
```

```

@staticmethod
def _edit_gui(value: NormalDistribution) -> tuple[bool, NormalDistribution]:
    # Note: we receive the current value and return a tuple with
    # a boolean indicating if the value was modified
    modified = False
    imgui.text("Edit Normal Distribution:")
    imgui.set_next_item_width(100)
    changed, new_mean = imgui.slider_float("Mean", value.mean, -10.0, 10.0)
    if changed:
        value.mean = new_mean
        modified = True
    imgui.set_next_item_width(100)
    changed, new_stddev = imgui.slider_float("StdDev", value.stddev, 0.1, 10.0)
    if changed:
        value.stddev = new_stddev
        modified = True

    return modified, value

def _present_gui(self, _value: NormalDistribution) -> None:
    # We do not use the value which was passed as a parameter as we use the cache
    # which was updated in the _on_change callback
    imgui_fig.fig("Normal Distribution", self.figure, refresh_image=self.shall_refresh)
    self.shall_refresh = False

```

### Step 3: Register the type

Finally, we register the custom type with its GUI, simply by calling the `register_type` function.

```
fl.register_type(NormalDistribution, NormalDistributionWithGui)
```

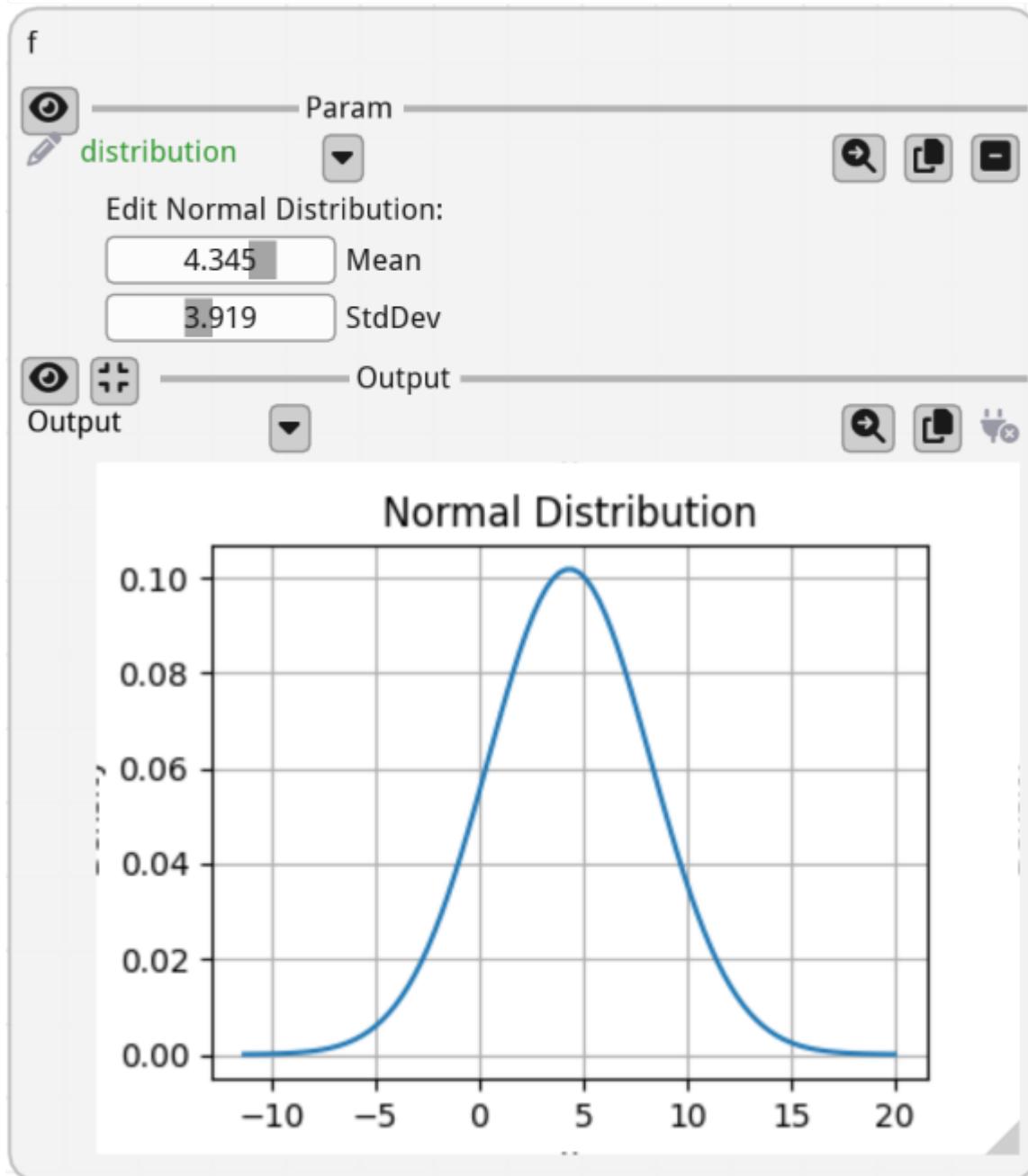
From now on, the `NormalDistribution` type will be associated with the `NormalDistributionWithGui` GUI: any function that uses `NormalDistribution` as a parameter or as a return type will automatically have a GUI for editing and presenting the `NormalDistribution` type.

### Step 4: Use the custom type in a function

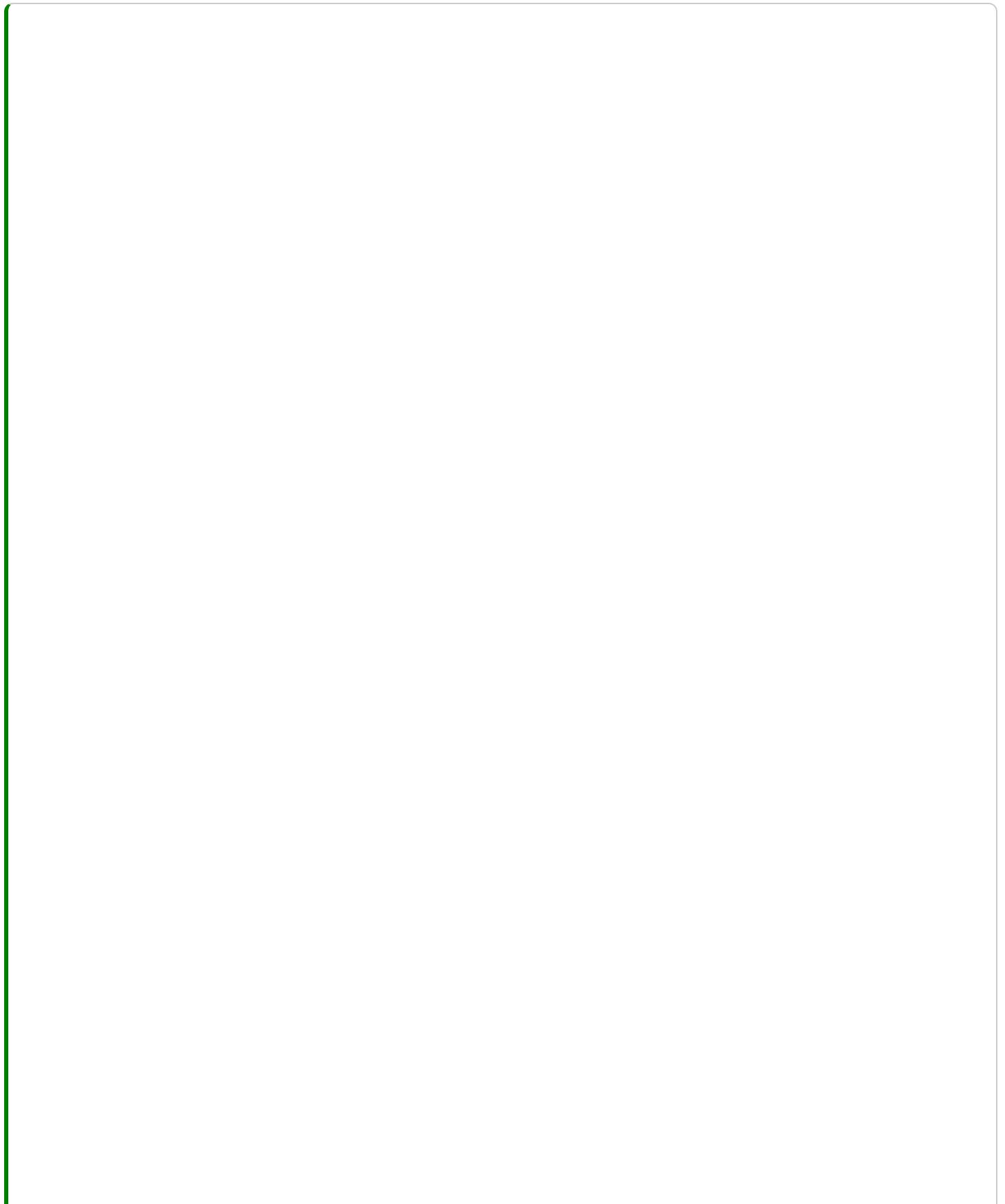
In this example, our function simply returns the `NormalDistribution` instance that was passed to it. In the screenshot, you can see the “edit” callback in action in the Param edition section, and the “present” callback in the Output section.

```
def f(distribution: NormalDistribution) -> NormalDistribution:  
    return distribution  
  
fl.run(f, app_name="Normal Distribution")
```

2024-07-04 23:40:32.252 Python[68193:11625526] ApplePersistenceIgnoreState: Existing



## Example 2: a Length type with imperial units



```

# Step 1: Define the custom type for which we want to create a GUI
# =====
from typing import NewType

Length = NewType("Length", float)

# Step 2: Create a class to handle the custom type
# =====
import fiatlight
from fiatlight import AnyDataWithGui
from fiatlight.fiat_widgets import fontawesome_6_ctx, icons_fontawesome_6
from typing import NewType, Any, Dict
from imgui_bundle import imgui, hello_imgui, imgui_ctx, ImVec4

# The specific GUI for our custom type
class LengthWithGui(AnyDataWithGui[Length]):
    use_imperial_units: bool = False

    def __init__(self) -> None:
        super().__init__(Length)
        self.callbacks.edit = self._edit # A custom callback for editing the data
        self.callbacks.present = self._present # A custom callback for presenting
        self.callbacks.present_str = self._present_str # A custom callback for pre-
        self.callbacks.default_value_provider = lambda: Length(1.0) # A custom cal-
        # custom callback for saving the GUI options (here, we save the imperial un-
        self.callbacks.save_gui_options_to_json = self._save_gui_options_to_json
        self.callbacks.load_gui_options_from_json = self._load_gui_options_from_jso

    def _edit(self, value: Length) -> tuple[bool, Length]:
        _, self.use_imperial_units = imgui.checkbox("Imperial", self.use_imperial_u

            format = "%.3g m" if not self.use_imperial_units else "%.3g yd"
            value_unit = value * 1.09361 if self.use_imperial_units else value
            imgui.set_next_item_width(hello_imgui.em_size(10))
            changed, new_value_unit = imgui.slider_float(
                "Value", value_unit, 1e-5, 1e11, format, imgui.SliderFlags_.logarithmic
            )
            if changed:
                value = Length(new_value_unit / 1.09361 if self.use_imperial_units else
        return changed, value

    @staticmethod
    def _present_str(value: Length) -> str:
        return f"Length: {value:.2f} m"

    @staticmethod
    def _present(value: Length) -> None:
        with fontawesome_6_ctx():
            yd = int(Length(value * 1.09361))
            inches = int((Length(value * 1.09361 - yd) * 36))
            bananas = int(value / 0.2)
            imgui.text(f"Length: {yd} yd {inches:.0f} in (aka {bananas})")

```

```

        imgui.same_line()
        with imgui_ctx.push_style_color(imgui.Col_.text.value, ImVec4(1, 0.5, 0
            imgui.text(Icons/fontawesome_6.ICON_FA_CARROT)
        imgui.same_line()
        imgui.text(")")

    def _save_gui_options_to_json(self) -> Dict[str, Any]:
        return {"use_imperial_units": self.use_imperial_units}

    def _load_gui_options_from_json(self, json: Dict[str, Any]) -> None:
        self.use_imperial_units = json.get("use_imperial_units", False)

# Step 3: Register the custom type with its GUI
# =====
from fiatlight import register_type

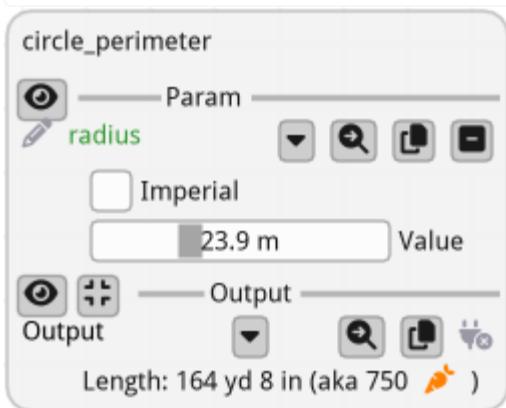
register_type(Length, LengthWithGui)

# Step 4: Use the custom type in a function
# =====
# A function that uses our custom type
def circle_perimeter(radius: Length) -> Length:
    return Length(2 * 3.14159 * radius)

# Run the function with the GUI
fiatlight.run(circle_perimeter, app_name="Circle Perimeter in banana units")

```

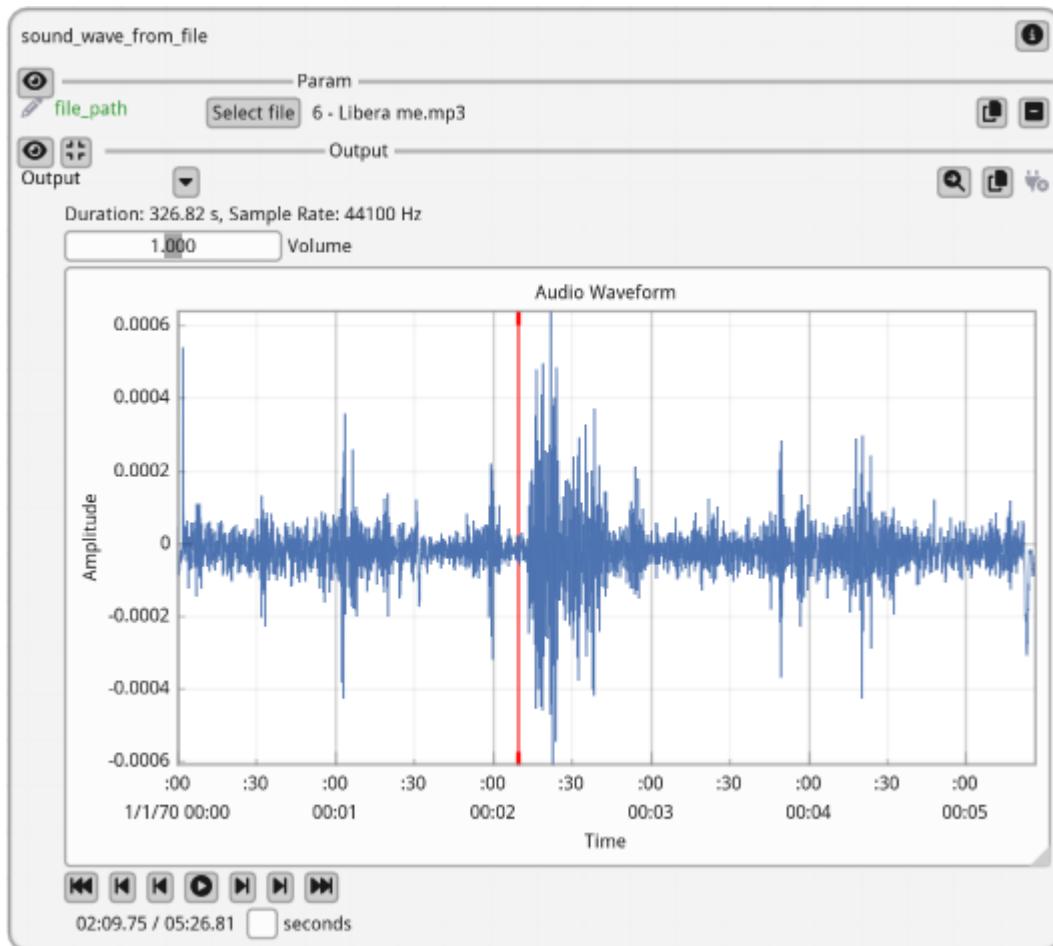
2024-07-04 23:40:37.134 Python[68193:11625526] WARNING: Secure coding is not enabled



## Example 3: a sound player

The sound wave player also uses a custom type with a GUI.

```
from fiatlight.fiat_kits.experimental.fiat_audio_simple import sound_wave_player_gui
sound_wave_player_gui_demo.main()
```



For more info, see its [source code](#)).

## How to create a new “fiat kit”

### fiat\_kit\_skeleton

[fiatlight.fiat\\_kits.fiat\\_skeleton](#) is a starting point for creating new widgets: it is a minimalistic kit that contains the necessary files to create a new widget.

```

fiat_kit_skeleton
├── __init__.py
├── mydata.py
└── mydata_presenter.py
    # An example data or library that you want to present
    # The presenter of the data
    # Also contains a derivate of PossibleCustomAttribute
    # where all the custom attributes are defined

    └── mydata_with_gui.py      # MyDataWithGui: the widget that will be displayed
# (inherits from AnyDataWithGui, implements all the callbacks
# of AnyDataGuiCallbacks, and uses MyDataPresenter for
# complex data presentation)

```

See files:

- [mydata.py](#)
- [mydata\\_presenter.py](#)
- [mydata\\_with\\_gui.py](#)

## fiat\_kit\_skeleton in action

[fiatlight.fiat\\_kits.fiat\\_dataframe](#) it was developed starting from the skeleton. It is a good example on how it can be customized.

```

fiat_dataframe
├── dataframe_presenter.py
    # The presenter of the data (presentation)
    # Also contains a derivate of PossibleCustomAttribute

    └── dataframe_with_gui.py
        # The widget that will be displayed in the application
        # (inherits from AnyDataWithGui, implements all the callbacks
        # of AnyDataGuiCallbacks, and uses DataframePresenter for
        # complex data presentation)

```

See files:

- [dataframe\\_presenter.py](#)
- [dataframe\\_with\\_gui.py](#)

## Run the demos

**Install optional dependencies**

In order to run the demos, you may need to install per domain dependencies:

- For AI demos: `pip install -r requirements-ai.txt`
- For audio demos: `pip install -r requirements-audio.txt`

## Standard demos

Several demos are available in the `src/python/flatlight/demos` folder:

```
%%bash
tree -I "__pycache__|flat_settings|priv_experiments|fonts|__init__.py" ../demos/ |
```

```
../demos/
├── ai
│   ├── demo_sdxl_meme.py
│   └── demo_sdxl_toon_edges.py
├── audio
│   ├── demo_audio_processing_link.py
│   ├── microphone_gui_demo_link.py
│   └── sound_wave_player_gui_demo_link.py
├── custom_graph
│   └── demo_custom_graph.py
├── hello_rosetta
│   ├── example_validation.py
│   └── hello_rosetta.py
├── images
│   ├── demo_computer_vision.py
│   ├── demo_oil_paint.py
│   ├── old_school_meme.py
│   ├── opencv_wrappers.py
│   └── toon_edges.py
├── math
│   ├── demo_binomial.py
│   ├── demo_float_functions.py
│   ├── demo_plot_array.py
│   └── demo_plot_manual_present.py
├── plots
│   └── demo_matplotlib.py
└── string
    ├── demo_word_count.py
    └── str_functions.py
```

## Notebook demos

You can also run all the demos that are present in the documentation (there are a lot of interesting demos, together with screenshots)

- install Jupyter: `pip install jupyter`
- Launch Jupyter with the following command: `jupyter lab`
- After Jupyter is launched, a browser page will open: navigate to the "src/python/fiatlight/doc" folder to find the demos.

# API

## Architecture

- [Fiatlight Architecture](#): Overview of the Fiatlight architecture, including the class diagrams and folders structure.

## fiat\_core

fiat\_core is the foundational package of the fiatlight framework. It focuses on wrapping data and functions with GUI elements to facilitate interaction.

Its most important classes are:

- [\*\*FunctionWithGui\*\*](#): Encapsulates a function, enriching it with a GUI based on inferred input and output types. It handles function invocation and manages internal states like exceptions and execution flags.
- [\*\*AnyDataWithGui\*\*](#): Wraps any type of data with a GUI. This class manages the data value and its associated callbacks, and it provides methods to serialize/deserialize the data to/from JSON.
- [\*\*AnyDataGuiCallbacks\*\*](#): Stores callback functions for AnyDataWithGui, enhancing interactivity by allowing custom widgets and presentations.
- [\*\*FunctionsGraph\*\*](#): Represents a graph of functions, where the output of one function can be linked to the input of another function. It allows the user to create complex workflows by chaining functions together.

# Fiatlight Architecture

```
# Necessary imports for this doc page
from fiatlight.fiat_notebook import plantuml_magic, display_markdown_from_file
```

## Class diagrams

### fiat\_core

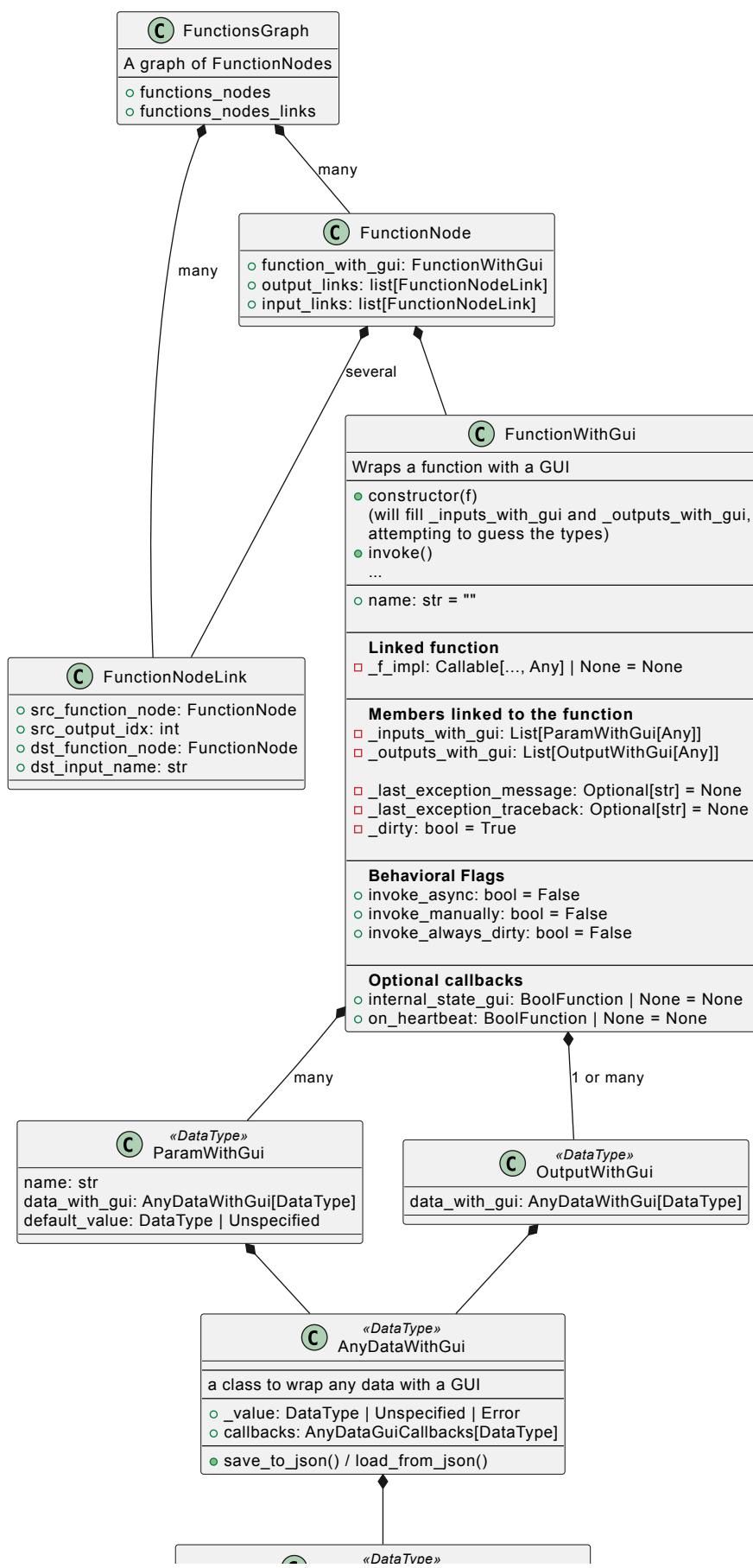
This is the foundational package of the fiatlight framework. It focuses on wrapping data and functions with GUI elements to facilitate interaction.

#### Classes

- **AnyDataWithGui**: Wraps any type of data with a GUI. This class manages the data value and its associated callbacks, and it provides methods to serialize/deserialize the data to/from JSON.
- **AnyDataGuiCallbacks**: Stores callback functions for AnyDataWithGui, enhancing interactivity by allowing custom widgets and presentations.
- **FunctionWithGui**: Encapsulates a function, enriching it with a GUI based on inferred input and output types. It handles function invocation and manages internal states like exceptions and execution flags.
- **ParamWithGui** and **OutputWithGui**: These classes link parameters and outputs of functions to their GUI representations.
- **FunctionNode**: Represents a node in a function graph, containing links to other function nodes and managing data flow between them.
- **FunctionNodeLink**: Defines a link between outputs of one function node and inputs of another, facilitating data flow in the function graph.
- **FunctionsGraph**: Represents a graph of interconnected FunctionNode instances, effectively mapping the entire functional structure.

```
%plantuml_include class_diagrams/fiat_core.puml
```

## flat\_core



This is the core of fiatlight.  
It is a set of classes that can be used to add a GUI to any data, function or graph of functions.  
It does depend on ImGui, but not on imgui-node-editor.

|   |
|---|
|  AnyDataGuiCallbacks   |
| a class that stores callbacks for AnyWithDataGui<br>(most of them are optional)   |
| <ul style="list-style-type: none"> <li>● edit : BoolFunction (custom widgets for edition)</li> <li>● present_custom: VoidFunction (for presentation)</li> <li>● etc.</li> </ul> |

## fiat\_togui

fiat\_togui provides functions to register new types (classes, dataclasses, enums) so that they are associated with a GUI.

### Functions

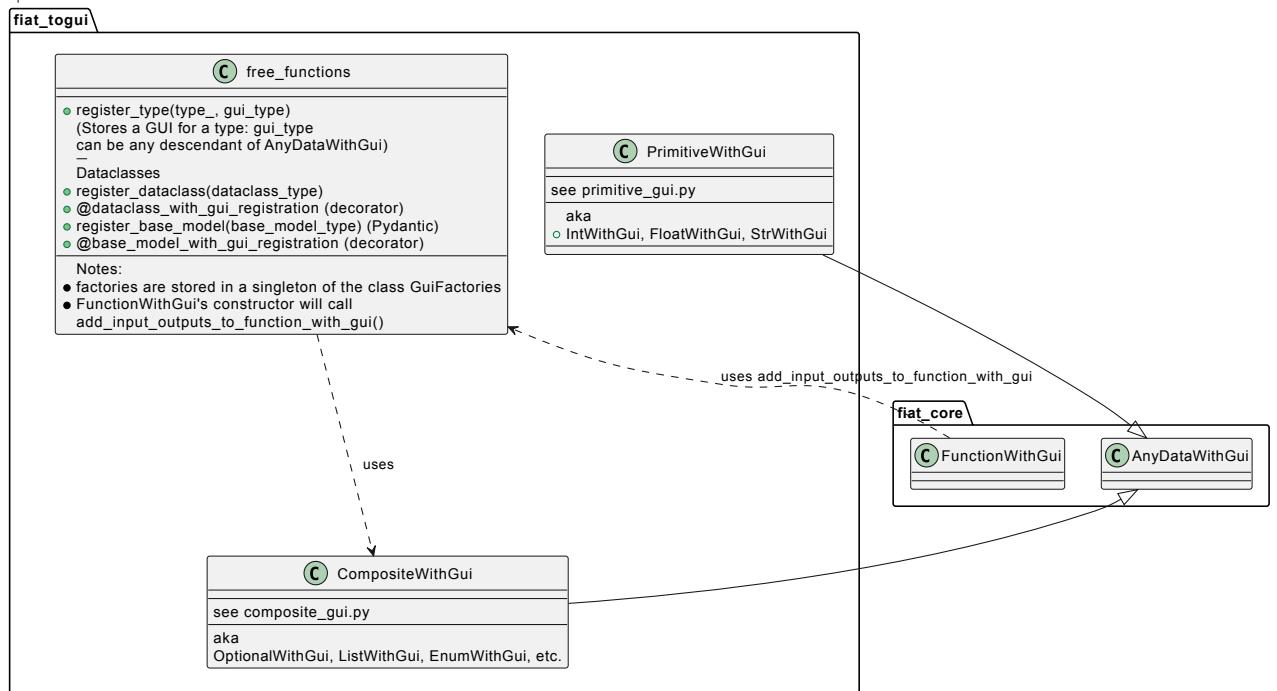
- `register_type(type_, gui_type)`: register a GUI for a given type. gui\_type must be a descendant of AnyWithDataGui
- `register_enum(enum_type)` and the equivalent decorator `enum_with_gui_registration`: register an enum
- `register_dataclass` and the equivalent decorator `dataclass_with_gui_registration`: register a dataclass base model
- `register_base_model` and the equivalent decorator `base_model_with_gui_registration`: register a pydantic base model

### Classes

- `IntWithGui`, `FloatWithGui`, etc.: provides GUI for primitive types (int, str, float, bool)
- `OptionalWithGui`: able to add GUI to Optional[DataType] (if DataType is registered)

```
%plantuml_include class_diagrams/fiat_togui.puml
```

This package contains a registry of GUI factories, able to emit GUI widgets for many data type.  
Consequently, it can also add input/output widgets to a function.



## fiat\_runner

`fiat_runner` is the package that contains the “run” functions:

### Free function

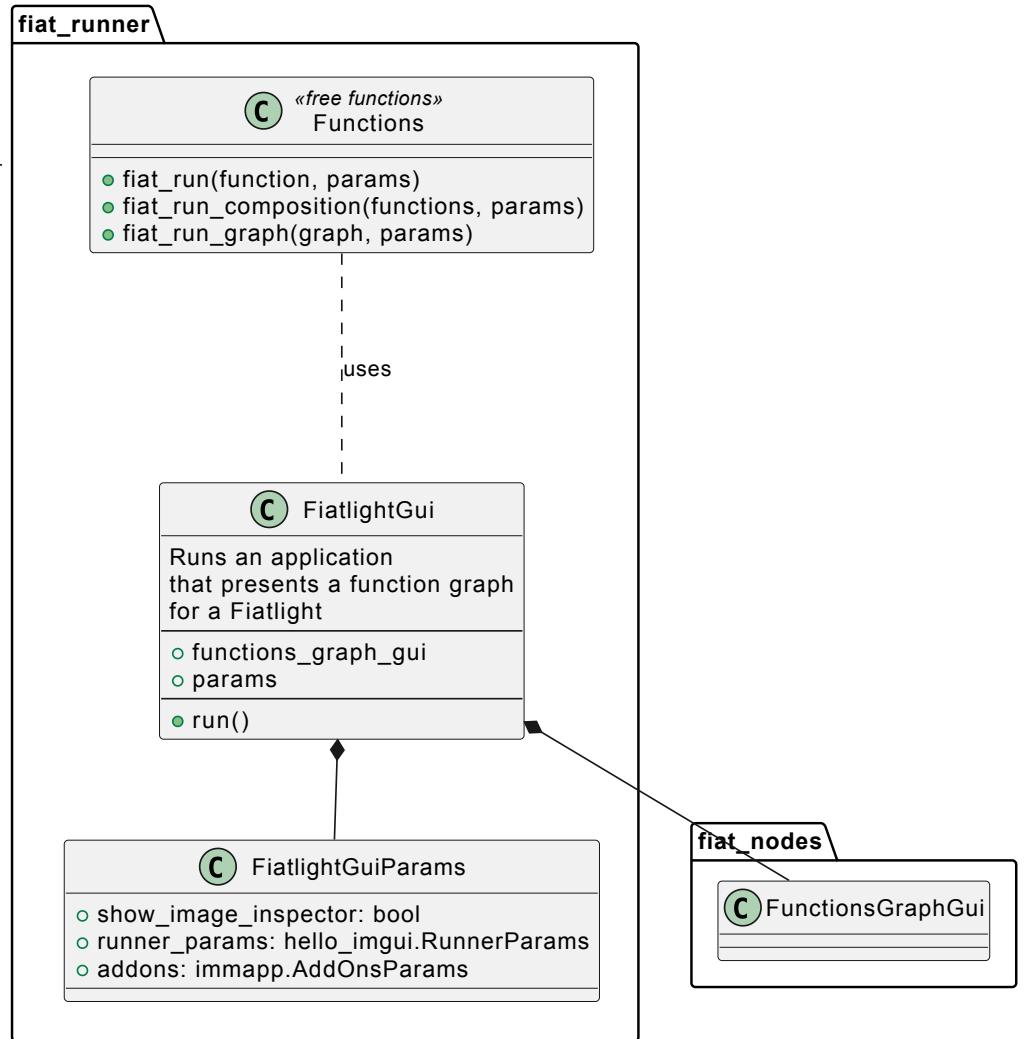
`fiat_run` accepts either a standard function, a list of functions, or a graph of functions. It executes the function(s) and displays the results in a GUI.

- `fiat_run(fn)` # fn is a function or a `FunctionWithGui`
- `fiat_run([fn1, fn2, ...])` # list of functions or `FunctionWithGui`
- `fiat_run(graph)` # A `FunctionsGraph`

### Classes

- `FiatlightGui`: The main runtime class that presents a GUI for interacting with a function graph. It orchestrates the execution and user interaction.
- `FiatlightGuiParams`: Stores configuration and parameters for the GUI application, such as visibility toggles and other settings.

```
%plantuml_include class_diagrams/flat_runner.puml
```



## flat\_nodes

`flat_nodes` is the package that is able to display a function graph in a node editor (using [imgui-node-editor](#))

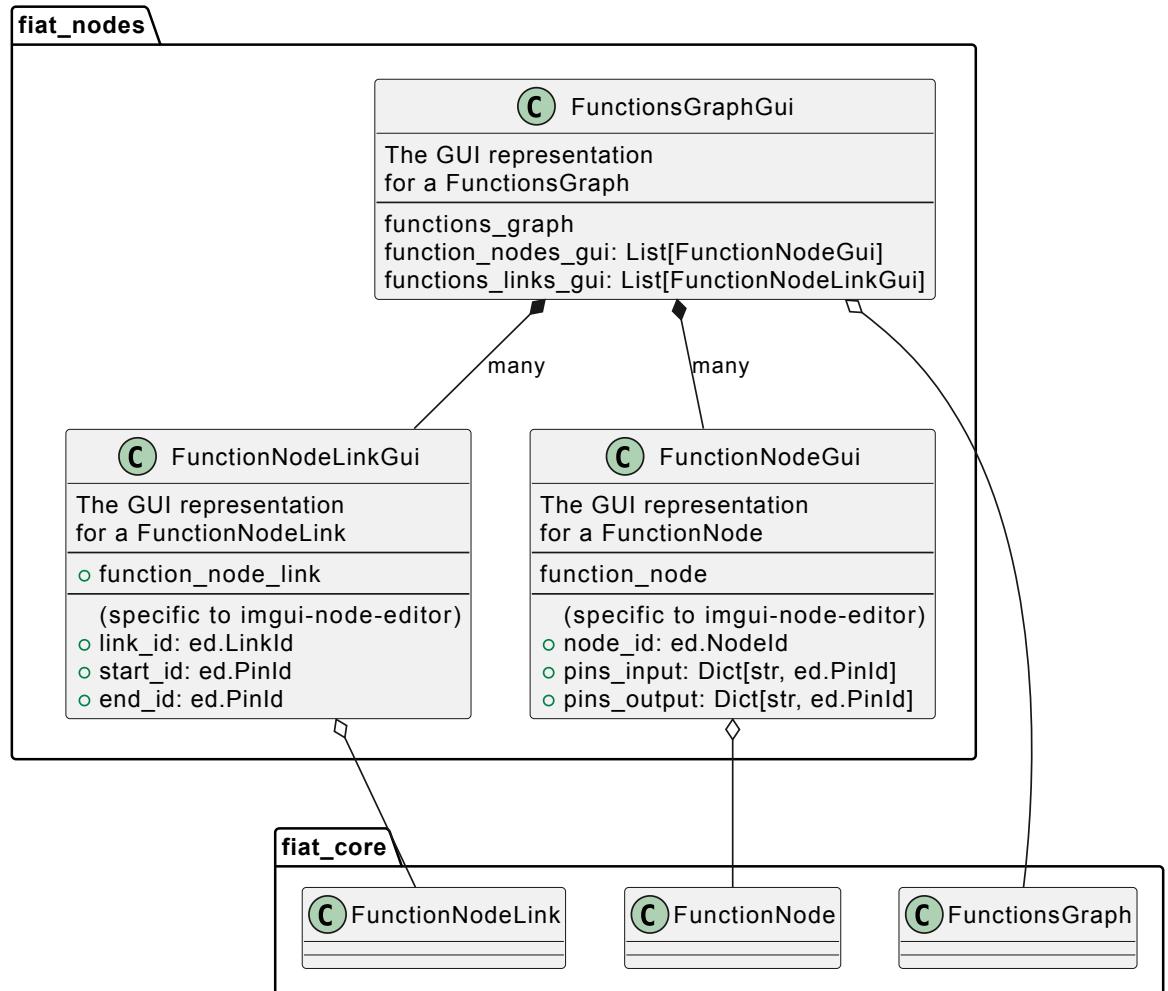
As a final user, you will probably not interact with it.

### Classes

- [FunctionNodeGui](#): The GUI representation of a `FunctionNode`
- [FunctionNodeLinkGui](#): The GUI representation aspect of a `FunctionNodeLink`
- [FunctionsGraphGui](#): The GUI representation of a `FunctionsGraph`

```
%plantuml_include class_diagrams/flat_nodes.puml
```

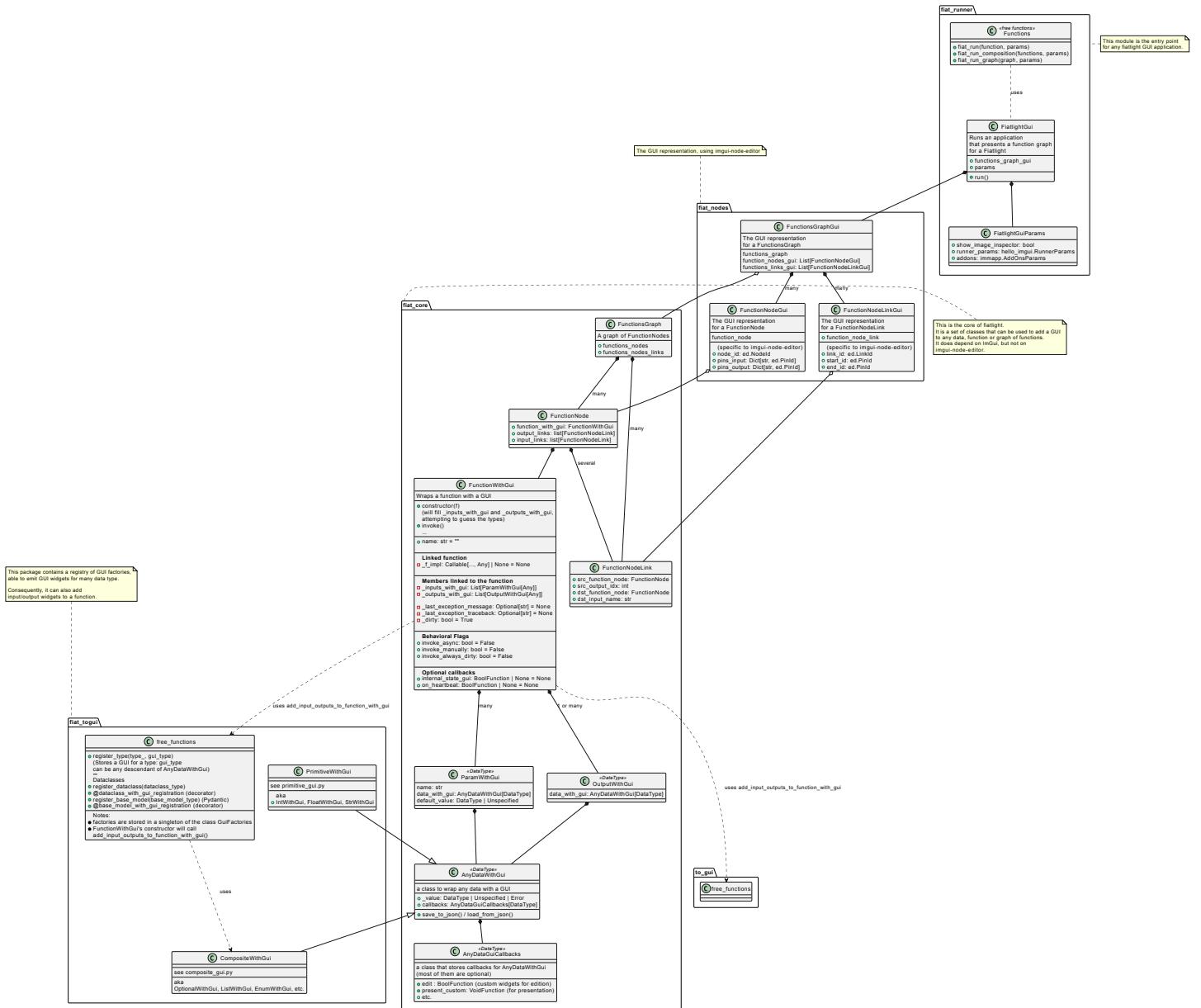
The GUI representation, using imgui-node-editor



## Full diagram

Below is the full class diagram

```
%plantuml_include class_diagrams/all.puml
```



# Folder structure

Below is the folder structure of the fiatlight framework.

```
display_markdown_from_file("folder_structure.md")
```

```
src/python/fiatlight//  
└── __init__.py  
    ├── fiat_core/  
    │   ├── __init__.py  
    │   ├── any_data_gui_callbacks.md  
    │   ├── any_data_gui_callbacks.py  
    │   ├── any_data_with_gui.md  
    │   ├── any_data_with_gui.py  
    │   ├── detailed_type.py  
    │   ├── function_node.py  
    │   ├── function_with_gui.py  
    │   ├── functions_graph.py  
    │   ├── output_with_gui.py  
    │   ├── param_with_gui.py  
    │   ├── possible_fiat_attributes.py  
    │   └── togui_exception.py  
  
    └── fiat_runner/  
        ├── __init__.py  
        ├── fiat_gui.py  
        ├── fiat_run_notebook.py  
        └── functions_collection.py  
  
    └── fiat_togui/  
        ├── Readme.md -> fiat_togui.md  
        ├── __init__.py  
        ├── composite_gui.py  
        ├── composite_gui_demo.py  
        ├── dataclass_examples.py  
        ├── dataclass_gui.py  
        ├── dataclass_gui_demo.py  
        ├── explained_value_gui.py  
        ├── fiat_togui.md  
        ├── file_types_gui.py  
        ├── file_types_gui_demo.py  
        ├── function_signature.py  
        ├── make_gui_demo_code.py  
        ├── primitive_gui_demo.py  
        ├── primitives_gui.py  
        ├── str_with_gui.py  
        ├── str_with_gui_demo.py  
        └── to_gui.py  
  
    └── fiat_config/  
        ├── __init__.py  
        ├── fiat_config_def.py  
        └── fiat_style_def.py  
  
    └── fiat_types/  
        ├── __init__.py  
        ├── base_types.py  
        ├── color_types.py  
        └── error_types.py
```

```
    ├── fiat_number_types.py
    ├── file_types.py
    ├── function_types.py
    └── str_types.py

    ├── fiat_kits/                                # domain specific kits
    │   ├── Readme.md -> fiat_kits.md
    │   └── __init__.py

    ├── fiat_image/                               # image widgets (ImageWithGui, LutGui,
    │   ├── Readme.md -> fiat_image.md
    │   ├── __init__.py
    │   ├── camera_image_provider.py
    │   ├── camera_image_provider_demo.py
    │   ├── cv_color_type.py
    │   ├── fiat_image.md
    │   ├── fiat_image_attrs_demo.py
    │   ├── image_gui.py
    │   ├── image_to_from_file_gui.py
    │   ├── image_to_from_file_gui_demo.py
    │   ├── image_types.py
    │   ├── lut_functions.py
    │   ├── lut_gui.py
    │   ├── lut_gui_demo.py
    │   ├── lut_types.py
    │   ├── overlay_alpha_image.py
    │   └── paris.jpg

    ├── fiat_matplotlib/                         # Matplotlib widget (FigureWithGui)
    │   ├── __init__.py
    │   ├── comparison_dash/
    │   │   ├── __init__.py
    │   │   └── figure_demo_dash.py
    │   ├── comparison_streamlit/
    │   │   ├── __init__.py
    │   │   ├── anim_wave_streamlit.py
    │   │   └── figure_demo_streamlit.py
    │   ├── fiat_matplotlib.md
    │   ├── figure_with_gui.py
    │   └── figure_with_gui_demo.py

    ├── fiat_dataframe/                           # Pandas DataFrame widget (DataFrameWj
    │   ├── Readme.md -> fiat_dataframe.md
    │   ├── __init__.py
    │   ├── dataframe_presenter.py
    │   ├── dataframe_with_gui.py
    │   ├── dataframe_with_gui_demo_titanic.py
    │   └── fiat_dataframe.md

    ├── fiat_implot/                            # Plots with ImPlot:
    │   ├── __init__.py
    │   ├── array_types.py
    │   ├── simple_plot_gui.py
    │   └── simple_plot_gui_demo.py
    │
    │   # SimplePlotGui presents 1D/2D arrays with ]
```

```
    └── fiat_ai/                                # Artificial Intelligence kit
        ├── __init__.py
        ├── invoke_sdxl_turbo.py
        ├── invoke_sdxl_turbo_demo.py
        ├── prompt.py
        ├── prompt_with_gui.py
        └── prompt_with_gui_demo.py

    └── fiat_kit_skeleton/                      # Kit skeleton
        ├── Readme.md -> fiat_skeleton.md      # (a starting point to create new kits)
        ├── __init__.py
        ├── fiat_skeleton.md
        ├── mydata.py
        ├── mydata_presenter.py
        └── mydata_with_gui.py

    └── experimental/
        ├── __init__.py
        └── fiat_audio_simple/                  # audio processing kit (experimental)
            ├── __init__.py
            ├── audio_types.py
            ├── audio_types_gui.py
            ├── microphone_gui.py
            ├── microphone_gui_demo.py
            ├── microphone_io.py
            ├── sound_wave_player.py
            ├── sound_wave_player_demo.py
            ├── sound_wave_player_gui.py
            └── sound_wave_player_gui_demo.py

    └── fiat_nodes/                            # Present function inside Nodes
        ├── __init__.py
        ├── function_node_gui.py
        └── functions_graph_gui.py

    └── fiat_utils/                           # internal utilities
        ├── __init__.py
        ├── docstring_utils.py
        ├── fiat_attributes_decorator.py
        ├── fiat_math.py
        ├── functional_utils.py
        ├── lazy_module.py
        ├── print_repeatable_message.py
        ├── registry.py
        └── str_utils.py

    └── fiat_widgets/                         # internal widgets
        ├── __init__.py
        ├── fiat_osd.py
        ├── float_widgets.py
        ├── fontawesome6_ctx_utils.py
        ├── group_panel.py
        └── mini_buttons.py
```

```
    └── misc_widgets.py
    └── node_separator.py
    └── ribbon_panel.py

    ├── fiat_cli/                                # Command Line Interface
    │   ├── __init__.py
    │   └── fiatlight_cli.py*
    │
    ├── fiat_doc/                               # documentation utilities
    │   ├── __init__.py
    │   ├── code_utils.py
    │   └── make_class_header.py
    │
    ├── fiat_notebook/                          # notebook utilities
    │   ├── look_at_code.py
    │   ├── notebook_utils.py
    │   └── plantuml_magic.py
    └── py.typed
```

# FunctionWithGui

## Introduction

`FunctionWithGui` is one of the core classes of FiatLight: it wraps a function with a GUI that presents its inputs and outputs.

- **Manual:** Read the [manual](#) for a detailed guide on how to use it.
- **Source code:** View its full code [online](#).

## Signature

Below, you will find the “signature” of the `FunctionWithGui` class, with its main attributes and methods (but not their bodies)

Its full source code is [available online](#).

```
from fiatlight.fiat_notebook import look_at_code
%look_at_class_header fiatlight.fiat_core.FunctionWithGui
```

```
class FunctionWithGui:
    """FunctionWithGui: add GUI to a function

`FunctionWithGui` is one of the core classes of FiatLight: it wraps a function + inputs and its output(s).

Public Members
=====
# the name of the function
name: str = ""

#
# Behavioral Flags
# -----
# invoke_async: if true, the function shall be called asynchronously
invoke_async: bool = False

# invoke_manually: if true, the function will be called only if the user clicks
# (if inputs were changed, a "Refresh needed" label will be displayed)
invoke_manually: bool = False

# invoke_always_dirty: if true, the function output will always be considered dirty
#   - if invoke_manually is true, the "Refresh needed" label will be displayed
#   - if invoke_manually is false, the function will be called at each frame
# Note: a "live" function is thus a function with invoke_manually=False and invoke_always_dirty=True
invoke_always_dirty: bool = False

# Optional user documentation to be displayed in the GUI
#   - doc_display: if True, the doc string is displayed in the GUI (default: False)
#   - doc_is_markdown: if True, the doc string is in Markdown format (default: False)
#   - doc_user: the documentation string. If not provided, the function docstring is used
#   - doc_show_source: if True, the source code of the function will be displayed
doc_display: bool = True
doc_markdown: bool = True
doc_user: str = ""
doc_show_source: bool = False

#
# Internal state GUI
# -----
# internal_state_gui: optional Gui for the internal state of the function
# (this function may display a GUI to show the internal state of the function,
# and return True if the state has changed, and the function needs to be called again)
internal_state_gui: BoolFunction | None = None

# internal_state_gui_node_compatible:
# If True, the internal_state_gui function is incompatible with being presented in a node editor
# (this is due to a limitation of the node editor, which cannot render scrollable widgets)
# Note: instead of setting edit_node_compatible to False, you may query
#       `flatlight.is_rendering_in_node()` to know if you are rendering in a node editor
#       and choose alternative widgets in this case.
internal_state_gui_node_compatible: bool = True
```

```

#
# Heartbeat
# -----
# on_heartbeat: optional function that will be called at each frame
# (and return True if the function needs to be called to update the output)
on_heartbeat: BoolFunction | None = None

#
# Serialization
# -----
# save/load_internal_gui_options_from_json (Optional)
# Optional serialization and deserialization of the internal state GUI presentation
# (i.e. anything that deals with how the GUI is presented, not the data itself)
# If provided, these functions will be used to recreate the GUI presentation opt
# so that the GUI looks the same when the application is restarted.
save_internal_gui_options_to_json: Callable[[], JsonDict] | None = None
load_internal_gui_options_from_json: Callable[[JsonDict], None] | None = None

"""
function_name: str = ''
label: str = ''
invoke_async: bool = False
invoke_manually: bool = False
invoke_always_dirty: bool = False
invoke_is_gui_only: bool = False
doc_display: bool = True
doc_markdown: bool = True
doc_user: str = ''
doc_show_source: bool = False
internal_state_gui: BoolFunction | None = None
internal_state_gui_node_compatible: bool = True
save_internal_gui_options_to_json: Callable[[], JsonDict] | None = None
load_internal_gui_options_from_json: Callable[[JsonDict], None] | None = None
on_heartbeat: BoolFunction | None = None
_dirty: bool = True
_f_impl: Callable[..., Any] | None = None
_inputs_with_gui: List[ParamWithGui[Any]]
_outputs_with_gui: List[OutputWithGui[Any]]
_last_exception_message: Optional[str] = None
_last_exception_traceback: Optional[str] = None
_accept_none_as_output: bool = False

class _Construct_Section:
"""
# -----
#       Construction
#   input_with_gui and output_with_gui should be filled soon after constructi
# -----
"""
pass

def __init__(self, fn: Callable[..., Any] | None, fn_name: str | None=None, *, :
    """Create a FunctionWithGui object, with the given function as implementatio

```

The function signature is automatically parsed, and the inputs and outputs are converted to the correct GUI types.

:param fn: the function for which we want to create a FunctionWithGui

Notes:

This function will capture the locals and globals of the caller to be able to call them. Make sure to call this function \*from the module where the function and its parameters are defined\*.

If the function has attributes like invoke\_manually or invoke\_async, they will be used:

- if `invoke\_async` is True, the function will be called asynchronously
- if `invoke\_manually` is True, the function will be called only if the caller has the right permissions

Advanced parameters:

\*\*\*\*\*

:param signature\_string: a string representing the signature of the function, used when the function signature cannot be retrieved from the function object

....

pass

class \_FiatAttributes\_Section:

....

# -----

# Fiat Attributes

# -----

....

pass

def handle\_fiat\_attributes(self, fiat\_attributes: dict[str, Any]) -> None:

"""Handle custom attributes for the function"""

pass

def set\_invoke\_live(self) -> None:

"""Set flags to make this a live function (called automatically at each frame)"""

pass

def set\_invoke\_manually(self) -> None:

"""Set flags to make this a function that needs to be called manually"""

pass

def set\_invoke\_manually\_io(self) -> None:

"""Set flags to make this a IO function that needs to be called manually and that is always considered dirty, because it depends on an external device or state (and likely has no input)"""

pass

def is\_invoke\_manually\_io(self) -> bool:

"""Return True if the function is an IO function that needs to be called manually"""

pass

def set\_invoke\_async(self) -> None:

"""Set flags to make this a function that is called asynchronously"""

pass

```
def is_live(self) -> bool:
    """Return True if the function is live"""
    pass

class _Utilities_Section:
    """
    -----
    # Utilities
    -----
    """
    pass

def call_for_tests(self, **params: Any) -> Any:
    """Call the function with the given parameters, for testing purposes"""
    pass

def is_dirty(self) -> bool:
    """Return True if the function needs to be called, because the inputs have changed"""
    pass

def set_dirty(self) -> None:
    """Set the function as dirty."""
    pass

def get_last_exception_message(self) -> str | None:
    """Return the last exception message, if any"""
    pass

def shall_display_refresh_needed_label(self) -> bool:
    """Return True if the "Refresh needed" label should be displayed
    i.e. if the function is dirty and invoke_manually is True"""
    pass

def __str__(self) -> str:
    pass

class _Inputs_Section:
    """
    -----
    # Inputs, aka parameters
    -----
    """
    pass

def nb_inputs(self) -> int:
    """Return the number of inputs of the function"""
    pass

def all_inputs_names(self) -> List[str]:
    """Return the names of all the inputs of the function"""
    pass

def input(self, name: str) -> AnyDataWithGui[Any]:
```

```
"""Return the input with the given name as a AnyDataWithGui[Any]
The inner type of the returned value is Any in this case.
You may have to cast it to the correct type, if you rely on type hints.

Use input_as() if you want to get the input with the correct type.
"""
pass

def input_as(self, name: str, gui_type: Type[GuiType]) -> GuiType:
    """Return the input with the given name as a GuiType

    GuiType can be any descendant of AnyDataWithGui, like
        fiatlight.fiat_core.IntWithGui, fiatlight.fiat_core.FloatWithGui, etc.

    Raises a ValueError if the input is not found, and a TypeError if the input
    """
    pass

def input_of_idx(self, idx: int) -> ParamWithGui[Any]:
    """Return the input with the given index as a ParamWithGui[Any]"""
    pass

def input_of_idx_as(self, idx: int, gui_type: Type[GuiType]) -> GuiType:
    """Return the input with the given index as a GuiType"""
    pass

def inputs_guis(self) -> List[AnyDataWithGui[Any]]:
    pass

def set_input_gui(self, name: str, gui: AnyDataWithGui[Any]) -> None:
    """Set the GUI for the input with the given name"""
    pass

def has_param(self, name: str) -> bool:
    """Return True if the function has a parameter with the given name"""
    pass

def param(self, name: str) -> ParamWithGui[Any]:
    """Return the input with the given name as a ParamWithGui[Any]"""
    pass

def param_gui(self, name: str) -> AnyDataWithGui[Any]:
    """Return the input with the given name as a AnyDataWithGui[Any]"""
    pass

def set_param_value(self, name: str, value: Any) -> None:
    """Set the value of the input with the given name
    This is useful to set the value of an input programmatically, for example in
    """
    pass

def toggle_expand_inputs(self) -> None:
    pass
```

```

def toggle_expand_outputs(self) -> None:
    pass

class _Outputs_Section:
    """
    # -----
    #       Outputs
    # -----
    """

    pass

def nb_outputs(self) -> int:
    """Return the number of outputs of the function.
    A function typically has 0 or 1 output, but it can have more if it returns a
    """
    pass

def output(self, output_idx: int=0) -> AnyDataWithGui[Any]:
    """Return the output with the given index as a AnyDataWithGui[Any]
    The inner type of the returned value is Any in this case.
    You may have to cast it to the correct type, if you rely on type hints.

    Use output_as() if you want to get the output with the correct type.
    """
    pass

def output_as(self, output_idx: int, gui_type: Type[GuiType]) -> GuiType:
    """Return the output with the given index as a GuiType

    GuiType can be any descendant of AnyDataWithGui, like
        fiatlight.fiat_core.IntWithGui, fiatlight.fiat_core.FloatWithGui, etc.

    Raises a ValueError if the output is not found, and a TypeError if the output
    """
    pass

def outputs_guis(self) -> List[AnyDataWithGui[Any]]:
    pass

class _Invoke_Section:
    """
    # -----
    #       Invoke the function
    # This is the heart of fiatlight: it calls the function with the current input
    # and stores the result in the outputs, stores the exception if any, etc.
    # -----
    """

    pass

@final
def has_bad_inputs(self) -> bool:
    pass

@final

```

```

def invoke(self) -> None:
    """Invoke the function with the current inputs, and store the result in the
    Will call the function if:
    - the inputs have changed since the last call
    - the function is dirty
    - none of the inputs is an error or unspecified

    If an exception is raised, the outputs will be set to ValueError, and the exception
    will be stored in the exception field.

    If the function returned None and the output is not allowed to be None, a ValueError
    will be raised. This is inferred from the function signature.
    """
    pass

def invoke_gui(self) -> None:
    pass

@final
def _invoke_impl(self) -> None:
    pass

def on_exit(self) -> None:
    """Called when the application is exiting
    Will call the on_exit callback of all the inputs and outputs
    """
    pass

def _can_emit_none_output(self) -> bool:
    """Return True if the function can emit None as output
    i.e.
    - either the function has no output
    - or the output can be None (i.e. the signature looks like `def f() -> int` or
    if the function has multiple outputs, we consider that it can not emit None)
    """
    pass

class _Serialize_Section:
    """
    # -----
    #       Save and load to json
    # Here, we only save the options that the user entered manually in the GUI:
    #   - the options of the inputs
    #   - the options of the outputs
    # -----
    """

    pass

def save_user_inputs_to_json(self) -> JsonDict:
    pass

def load_user_inputs_from_json(self, json_data: JsonDict) -> None:
    pass

```

```

def save_gui_options_to_json(self) -> JsonDict:
    """Save the GUI options to a JSON file
    (i.e. any presentation options of the inputs and outputs, as well as of the
    """
    pass

def load_gui_options_from_json(self, json_data: JsonDict) -> None:
    """Load the GUI options from a JSON file"""
    pass

class _Doc_Section:
    pass

def get_function_doc(self) -> FunctionWithGuiDoc:
    pass

def _get_function_userdoc(self) -> str | None:
    """Return the user documentation of the function"""
    pass

def _get_function_docstring(self) -> str | None:
    """Return the docstring of the function"""
    pass

def _get_function_source_code(self) -> str | None:
    """Return the source code of the function"""
    pass

```

## Architecture

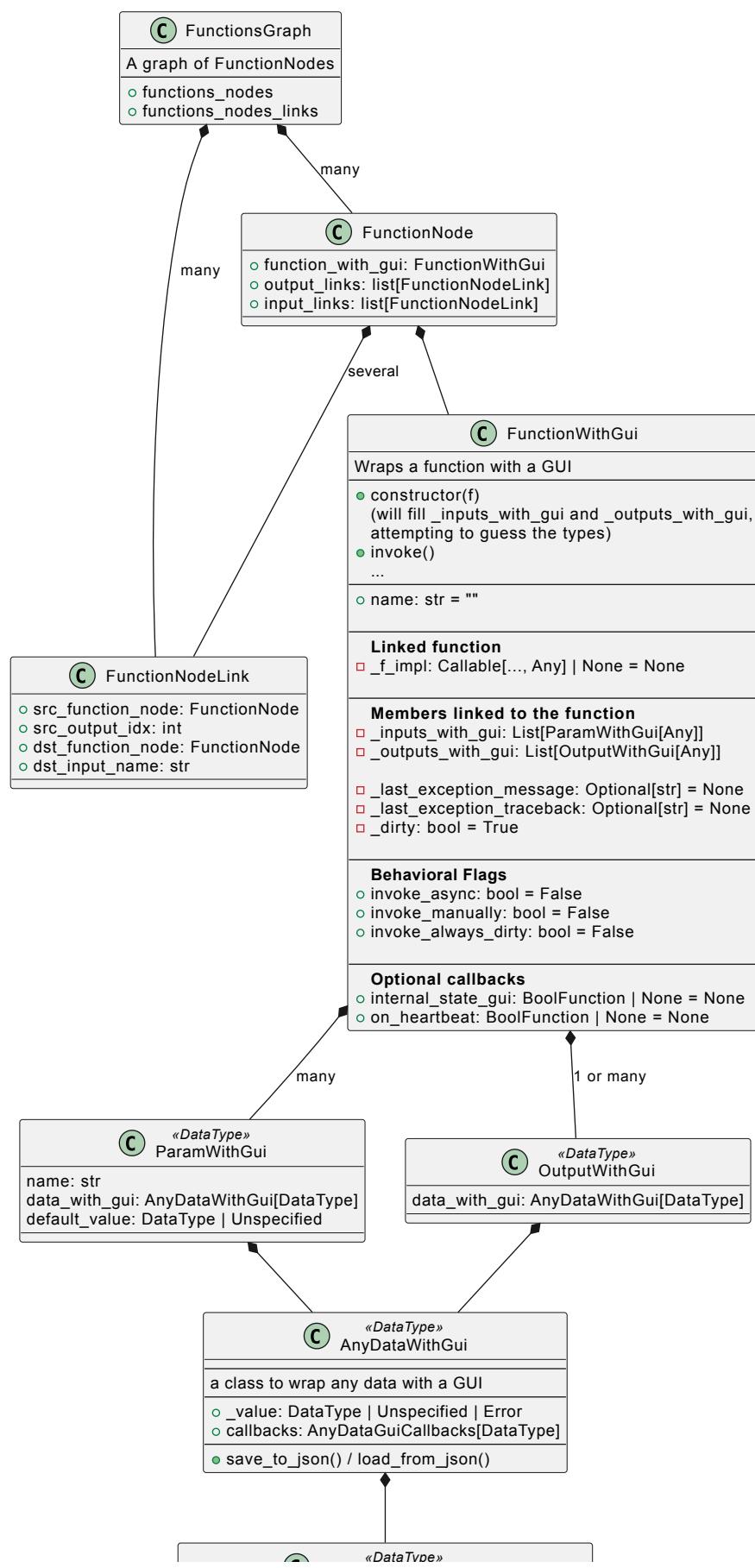
Below is a PlantUML diagram showing the architecture of the `fiat_core` module. See the [architecture page](#) for the full architecture diagrams.

```

from fiatlight.fiat_notebook import plantuml_magic
%plantuml_include class_diagrams/fiat_core.puml

```

## flat\_core



This is the core of fiatlight.  
It is a set of classes that can be used to add a GUI to any data, function or graph of functions.  
It does depend on ImGui, but not on imgui-node-editor.

| AnyDataGuiCallbacks   |
|---|
| a class that stores callbacks for AnyWithDataGui<br>(most of them are optional)                             |
| edit : BoolFunction (custom widgets for edition)<br>present_custom: VoidFunction (for presentation)<br>etc. |

# AnyWithDataGui

## Introduction

AnyWithDataGui associate a GUI to any type, with associated GUI callbacks, allowing for custom rendering, editing, serialization, and event handling within the Fiatlight framework.

It uses callbacks which are stored inside [AnyDataGuiCallback](#).

## Signature

Below, we display the class header, i.e., the class without its methods bodies, to give a quick overview of its structure.

You can see its full code at [AnyWithDataGui](#).

```
from fiatlight.fiat_notebook import look_at_code
%look_at_class_header fiatlight.fiat_core.AnyWithDataGui
```

```

class AnyDataWithGui(Generic[DataType]):
    """AnyDataWithGui: a GUI associated to a type.

AnyDataWithGui[DataType]
=====

This class manages data of any type with associated GUI callbacks, allowing for
serialization, and event handling within the Fiatlight framework.

Members:
-----
# The type of the data, e.g. int, str, typing.List[int], typing.Tuple[int, str],
_type: Type[DataType]

# The value of the data – can be a DataType, Unspecified, or Error
# It is accessed through the value property, which triggers the on_change callback
_value: DataType | Unspecified | Error = UnspecifiedValue

# Callbacks for the GUI
# This is the heart of FiatLight: the GUI is defined by the callbacks.
# Think of them as __dunder__ methods for the GUI.
callbacks: AnyDataGuiCallbacks[DataType]

# If True, the value can be None. This is useful when the data is optional.
# Otherwise, any None value will be considered as an Error.
# Note: when using Optional[any registered type], this flag is automatically set
can_be_none: bool = False

Property:
-----
# Custom attributes that can be set by the user, to give hints to the GUI.
# For example, with this function declaration,
#     def f(x: int, y: int) -> int:
#         return x + y
#     f.x__range = (0, 10)
# fiat_attributes["range"] will be (0, 10) for the parameter x.
@property
fiat_attributes -> dict[str, Any]

.....
_type: Type[DataType] | None
_value: DataType | Unspecified | Error | Invalid[DataType] = UnspecifiedValue
callbacks: AnyDataGuiCallbacks[DataType]
can_be_none: bool = False
_fiat_attributes: FiatAttributes
_expanded: bool = False
_can_set_unspecified_or_default: bool = False
label: str | None = None
label_color: ImVec4 | None = None
tooltip: str | None = None
status_tooltip: str | None = None

class CollapseOrExpand(Enum):

```

```
collapse = 'Collapse All'
expand = 'Expand All'

class PresentOrEdit(Enum):
    present = 'View'
    edit = 'Edit'

class _Init_Section:
"""
# -----
#           Initialization
# -----
"""

pass

def __init__(self, data_type: Type[DataType] | None) -> None:
    """Initialize the AnyWithDataWithGui with a type, an unspecified value, and no changes.
    pass

class _Value_Section:
"""
# -----
#           Value getter and setter + get_actual_value (which returns a DataType)
# -----
"""

pass

@property
def value(self) -> DataType | Unspecified | Error | Invalid[DataType]:
    """The value of the data, accessed through the value property.
    Warning: it might be an instance of `Unspecified` (user did not enter any value).
    """
    pass

@value.setter
def value(self, new_value: DataType | Unspecified | Error | Invalid[DataType]) -> None:
    """Set the value of the data. This triggers the on_change callback (if set).
    pass

def get_actual_value(self) -> DataType:
    """Returns the actual value of the data, or raises an exception if the value is invalid.
    When we are inside a callback, we can be sure that the value is of the correct type instead of accessing the value directly and checking for Unspecified or Error.
    """
    pass

def get_actual_or_invalid_value(self) -> DataType:
    """Returns the actual value of the data, or raises an exception if the value is invalid.
    pass

class _CustomAttributes_Section:
"""
# -----
#           Custom Attributes
# -----
"""

pass
```

```
# -----
#"""
#    pass

@staticmethod
def possible_fiat_attributes() -> PossibleFiatAttributes | None:
    """Return the possible custom attributes for this type, if available.
    Should be overridden in subclasses, when custom attributes are available.

    It is strongly advised to return a class variable, or a global variable
    to avoid creating a new instance each time this method is called.
    """
    pass

@final
def possible_fiat_attributes_with_generic(self) -> tuple[PossibleFiatAttributes
    pass

@property
def fiat_attributes(self) -> FiatAttributes:
    pass

def merge_fiat_attributes(self, fiat_attrs: FiatAttributes) -> None:
    """Merge custom attributes with the existing ones"""
    pass

def _handle_genericAttrs(self) -> None:
    """Handle generic custom attributes"""
    pass

@staticmethod
def propagate_label_and_tooltip(a: 'AnyDataWithGui[Any]', b: 'AnyDataWithGui[Any]'):
    """Propagate label and tooltip from one AnyDataWithGui to another
    Meant to be used with CompositeGui
    """
    pass

class _Gui_Section:
    """
    # -----
    #           Gui sections
    #       (Can also be used outside a function Node)
    # -----
    """

    def sub_items_can_collapse(self, _present_or_edit: PresentOrEdit) -> bool:
        """Overwrite this in derived classes if they provide multiple sub-items that
        pass

    def sub_itemsCollapseOrExpand(self, _collapse_or_expand: CollapseOrExpand) ->
        """Overwrite this in derived classes if they provide multiple sub-items that
        pass

    def sub_itemsWillCollapseOrExpand(self, _present_or_edit: PresentOrEdit) ->
```

```
"""Overwrite this in derived classes if they provide multiple sub-items that
pass

def _show_collapse_sub_items_buttons(self, present_or_edit: PresentOrEdit) -> None:
    pass

def can_show_present_popup(self) -> bool:
    pass

def can_show_edit_popup(self) -> bool:
    pass

def _show_collapse_button(self) -> None:
    pass

def _show_copy_to_clipboard_button(self) -> None:
    pass

def can_collapse_present(self) -> bool:
    pass

def can_collapse_edit(self) -> bool:
    pass

def can_edit_on_header_line(self) -> bool:
    pass

def can_present_on_header_line(self) -> bool:
    pass

def _can_edit_on_next_lines_if_expanded(self) -> bool:
    pass

def _can_present_on_next_lines_if_expanded(self) -> bool:
    pass

def _is_editing_on_next_lines(self) -> bool:
    pass

def _is_presenting_on_next_lines(self) -> bool:
    pass

def _popup_window_name(self, params: GuiHeaderLineParams[DataType], present_or_edit: PresentOrEdit) -> str:
    pass

def _gui_present_header_line(self, params: GuiHeaderLineParams[DataType]) -> None:
    """Present the value as a string in one line, or as a widget if it fits on one line
    pass

def _gui_edit_header_line(self, params: GuiHeaderLineParams[DataType]) -> bool:
    pass

def _show_set_unspecified_or_default_button(self) -> bool:
    pass
```

```
def _gui_edit_next_lines(self, in_popup: bool) -> bool:
    pass

def _gui_present_next_lines(self, in_popup: bool) -> None:
    pass

def gui_present_customizable(self, params: GuiHeaderLineParams[DataType]) -> None:
    """Present the value using either the present callback or the default str representation
    May present on one line (if possible) or on multiple lines with an expand button
    """
    pass

def gui_present(self) -> None:
    pass

def gui_edit_customizable(self, params: GuiHeaderLineParams[DataType]) -> bool:
    """Call the edit callback. Returns True if the value has changed
    May edit on one line (if possible) or on multiple lines with an expand button
    """
    pass

def gui_edit(self) -> bool:
    pass

class _Callbacks_Section:
    """
    -----
    #           Callbacks sections
    -----
    """

    def set_edit_callback(self, edit_callback: DataEditFunction[DataType]) -> None:
        """Helper function to set the edit callback from a free function"""
        pass

    def set_present_callback(self, present_callback: DataPresentFunction[DataType],
                           """Helper function to set the present custom callback from a free function"""
                           pass

    def add_validate_value_callback(self, cb: Callable[[DataType], None]) -> None:
        pass

    def _Serialization_Section(self) -> None:
        """
        -----
        #           Serialization and deserialization
        -----
        """

        pass

    @final
    def call_save_to_dict(self, value: DataType | Unspecified | Error | Invalid[DataType]
                         """Serialize the value to a dictionary
                         """
```

```
Will call the save_to_dict callback if set, otherwise will use the default serialization
A default serialization is available for primitive types, tuples, and Pydantic models

(This is how fiatlight saves the data to a JSON file)

Do not override these methods in descendant classes!
"""
pass

@final
def call_load_from_dict(self, json_data: JsonDict) -> DataType | Unspecified | None:
    """Deserialize the value from a dictionary
    Do not override these methods in descendant classes!
    """
    pass

@final
def call_save_gui_options_to_json(self) -> JsonDict:
    pass

@final
def call_load_gui_options_from_json(self, json_data: JsonDict) -> None:
    pass

class _Utilities_Section:
    """
    -----
    # Utilities
    -----
    """

    def can_construct_default_value(self) -> bool:
        pass

    def construct_default_value(self) -> DataType:
        pass

    def datatype_qualified_name(self) -> str:
        pass

    def datatype_basename(self) -> str:
        pass

    def datatype_base_and_qualified_name(self) -> str:
        pass

    def datatype_value_to_str(self, value: DataType) -> str:
        """Convert the value to a string
        Uses either the present_str callback, or the default str conversion
        """
        pass

    def datatype_value_to_clipboard_str(self, value: DataType) -> str:
        pass
```

```
"""Convert the value to a string for the clipboard
Uses either the clipboard_copy_str callback, or the default str conversion
"""
pass

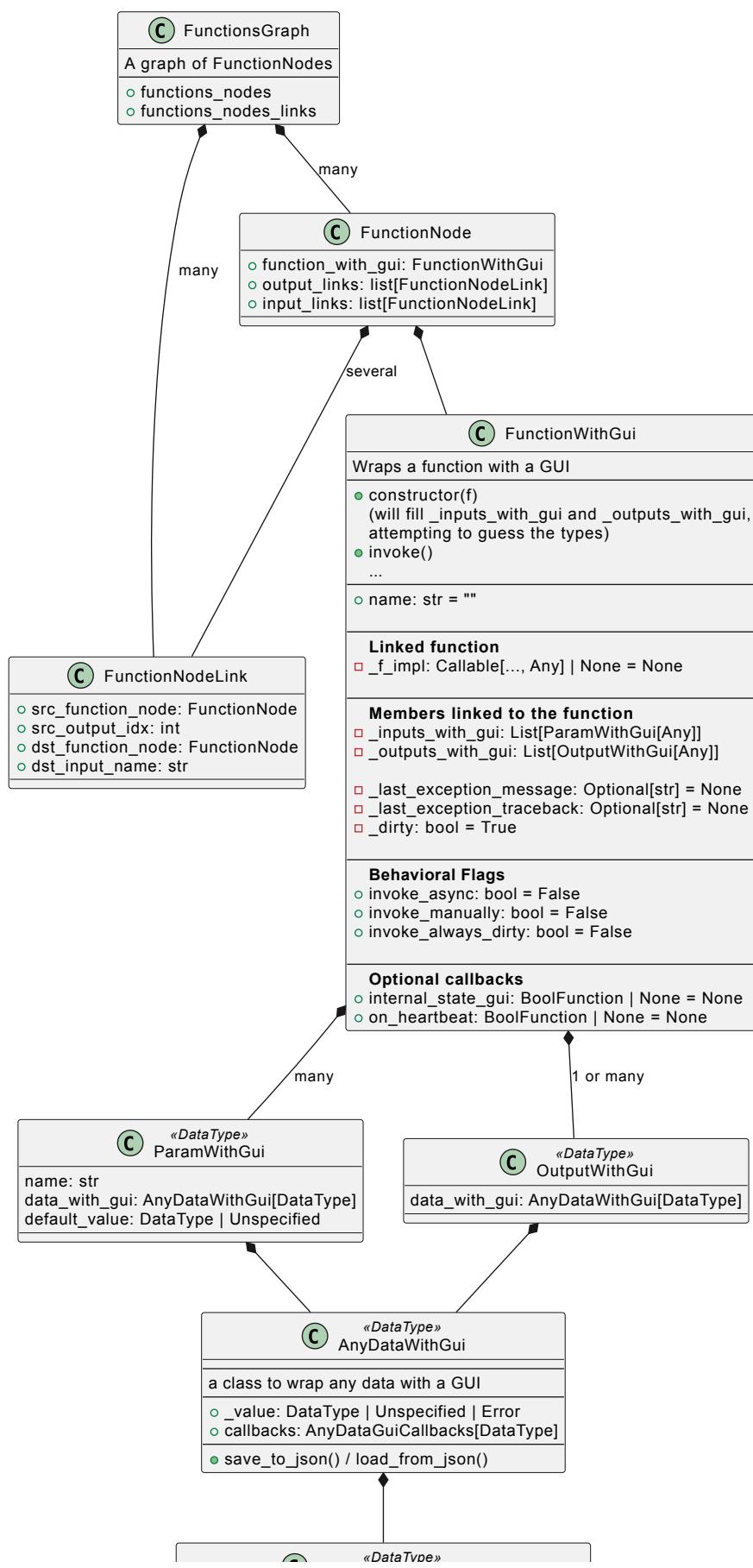
def docstring_first_line(self) -> str | None:
    """Return the first line of the docstring, if available"""
    pass
```

## Architecture

Below is a PlantUML diagram showing the architecture of the `fiat_core` module. See the [architecture page](#) for the full architecture diagrams.

```
from fiatlight.fiat_notebook import plantuml_magic
%plantuml_include class_diagrams/fiat_core.puml
```

## flat\_core



This is the core of fiatlight.  
It is a set of classes that can be used to add a GUI to any data, function or graph of functions.  
It does depend on ImGui, but not on imgui-node-editor.

| AnyDataGuiCallbacks   |
|---|
| a class that stores callbacks for AnyDataWithGui<br>(most of them are optional)                             |
| edit : BoolFunction (custom widgets for edition)<br>present_custom: VoidFunction (for presentation)<br>etc. |

# AnyDataGuiCallbacks

## Introduction

AnyDataGuiCallbacks provides a set of callbacks that define how a particular data type should be presented, edited, and managed within the Fiatlight GUI framework.

These callbacks are used by [AnyDataWithGui](#).

## Source

Below, is the class source, which you can also see [online](#).

```
from fiatlight.fiat_notebook import look_at_code
%look_at_python_code fiatlight.fiat_core.AnyDataGuiCallbacks
```

```
class AnyDataGuiCallbacks(Generic[DataType]):  
    """AnyDataGuiCallbacks: Collection of callbacks for a given type
```

```
AnyDataGuiCallbacks  
=====
```

This class provides a set of callbacks that define how a particular data type is presented, edited, and managed within the Flatlight GUI framework.

These callbacks are used by [AnyDataWithGui](any\_data\_with\_gui).

```
====
```

```
#             Presentation  
# -----  
# present_str: (Mandatory if str() is not enough, optional otherwise)  
# Provide a function that returns a short string info about the data content  
# This string will be presented as a short description of the data in the GUI  
#  
# If possible, it should be short enough to fit in a single line inside a node  
# If the result string is too long, or occupies more than one line, it will be truncated  
# (and the rest of the string will be displayed in a tooltip)  
# For example, on complex types such as images, return something like "128x128x3"  
# If not provided, the data will be presented using str()  
present_str: Callable[[DataType], str] | None = None  
  
# present: (Optional)  
# a function that provides a more complex, custom GUI representation of the data  
# It will be presented when a function param is in "expanded" mode, and can use  
# If not provided, the data will be presented using present_str  
#  
# Note: Some widgets cannot be presented in a Node (e.g., a multiline text input).  
#       You can query `flatlight.is_rendering_in_node()` to know if you are rendering  
#       inside a Node.  
#       Also, when inside a Node, you may want to render a smaller version, to save  
#       memory (as opposed to rendering a larger version in a detached window).  
present: Callable[[DataType], None] | None = None  
  
# present_collapsible:  
# Set this to False if your custom presentation is small and fits in one line  
# (i.e. it does not need to be collapsible)  
# If True, the gui presentation will either:  
#     - show present_str + an expand button  
#     - show the custom presentation + a collapse button  
present_collapsible: bool = True  
  
# present_node_compatible: (Optional: set to False if using input_text_multiline)  
# If True, the present function is incompatible with being presented in a node (e.g.  
# of the node editor, which cannot render scrollable widgets)  
# Note: instead of setting edit_node_compatible to False, you may query  
#       `flatlight.is_rendering_in_node()` to know if you are rendering in a node  
#       and choose alternative widgets in this case.  
present_node_compatible: bool = True
```

```

# -----
#           Edition
# -----
# edit: (Mandatory if edition is required)
# Provide a function that presents an editable interface for the data, and return
#   (True, new_value) if changed
#   (False, old_value) if not changed
# If not provided, the data will be presented as read-only
# Note: Some widgets cannot be presented in a Node (e.g., a multiline text input)
#       You can query `flatlight.is_rendering_in_node()` to know if you are rendering
edit: Callable[[DataType], tuple[bool, DataType]] | None = None

# edit_collapsible:
# Set this to False if your custom edition is small, and does not need to be collapsible
# If True, the gui edition will either:
#   - show present_str + an expand button
#   - show the custom edition + a collapse button
edit_collapsible: bool = True

# edit_node_compatible: (Optional: set to False if using input_text_multiline, etc)
# If True, the edit function is incompatible with being presented in a node (this is
# of the node editor, which cannot render scrollable widgets)
# Note: instead of setting edit_node_compatible to False, you may query
#       `flatlight.is_rendering_in_node()` to know if you are rendering in a node
#       and choose alternative widgets in this case.
edit_node_compatible: bool = True

# -----
#           Default value
# -----
# default value provider (Needed only for a type without default constructor)
# this function will be called to provide a default value if needed
default_value_provider: Callable[[], DataType] | None = None
# -----


#           Events callbacks
# -----
# on_change (Optional)
# if provided, this function will be called when the value changes.
# Can be used in more advanced cases,
# for example when `present` has an internal cache that needs to be updated,
# or other side effects.
on_change: Callable[[DataType], None] | None = None

# validate_value (Optional)
# if provided, these functions will be called when the user tries to set a value
# They should return a DataValidationResult.ok() if the value is valid,
# or a DataValidationResult.error() with an error message.
validate_value: list[Callable[[DataType], DataValidationResult]]


# on_exit (Optional)
# if provided, this function will be called when the application is closed.

```

```
# Used in more advanced cases, typically when some resources need to be released
on_exit: VoidFunction | None = None

# on_heartbeat: (Optional)
# If provided, this function will be called at each heartbeat of the function no
# (before the value is drawn). It should return True if any change has been made
on_heartbeat: BoolFunction | None = None

# on_fiat_attributes_changed (Optional)
# if provided, this function will be called when the custom attributes of the da
# Used in more advanced cases, when the data presentation depends on custom attri
on_fiat_attributes_changed: Callable[[FiatAttributes], None] | None = None

# -----
#                               Serialization and deserialization
# -----
# Of the GUI presentation options (not the data itself)
#
# save/load_gui_options_from_json (Optional)
# Optional serialization and deserialization of the GUI presentation options
# (i.e. anything that deals with how the data is presented in the GUI, *not the
# If provided, these functions will be used to recreate the GUI presentation opt
# so that the GUI looks the same when the application is restarted.
save_gui_options_to_json: Callable[[], JsonDict] | None = None
load_gui_options_from_json: Callable[[JsonDict], None] | None = None

# Of the data itself
#
# Optional serialization and deserialization functions for DataType
# If provided, these functions will be used to serialize and deserialize the dat
# If not provided, "value" will be serialized as a dict of its __dict__ attribut
# or as a json string (for int, float, str, bool, and None)
save_to_dict: Callable[[DataType], JsonDict] | None = None
load_from_dict: Callable[[JsonDict], DataType] | None = None
# -----
#                               Clipboard
# -----
# clipboard_copy_str (Optional)
# if provided, this function will be called when the value is copied to the clip
# Used in more advanced cases, when the data is not a simple string, or when pre
clipboard_copy_str: Callable[[DataType], str] | None = None

# clipboard_copy_possible (Optional)
# True by default
# If False, the user can not copy the data to the clipboard
clipboard_copy_possible: bool = True
# -----
```

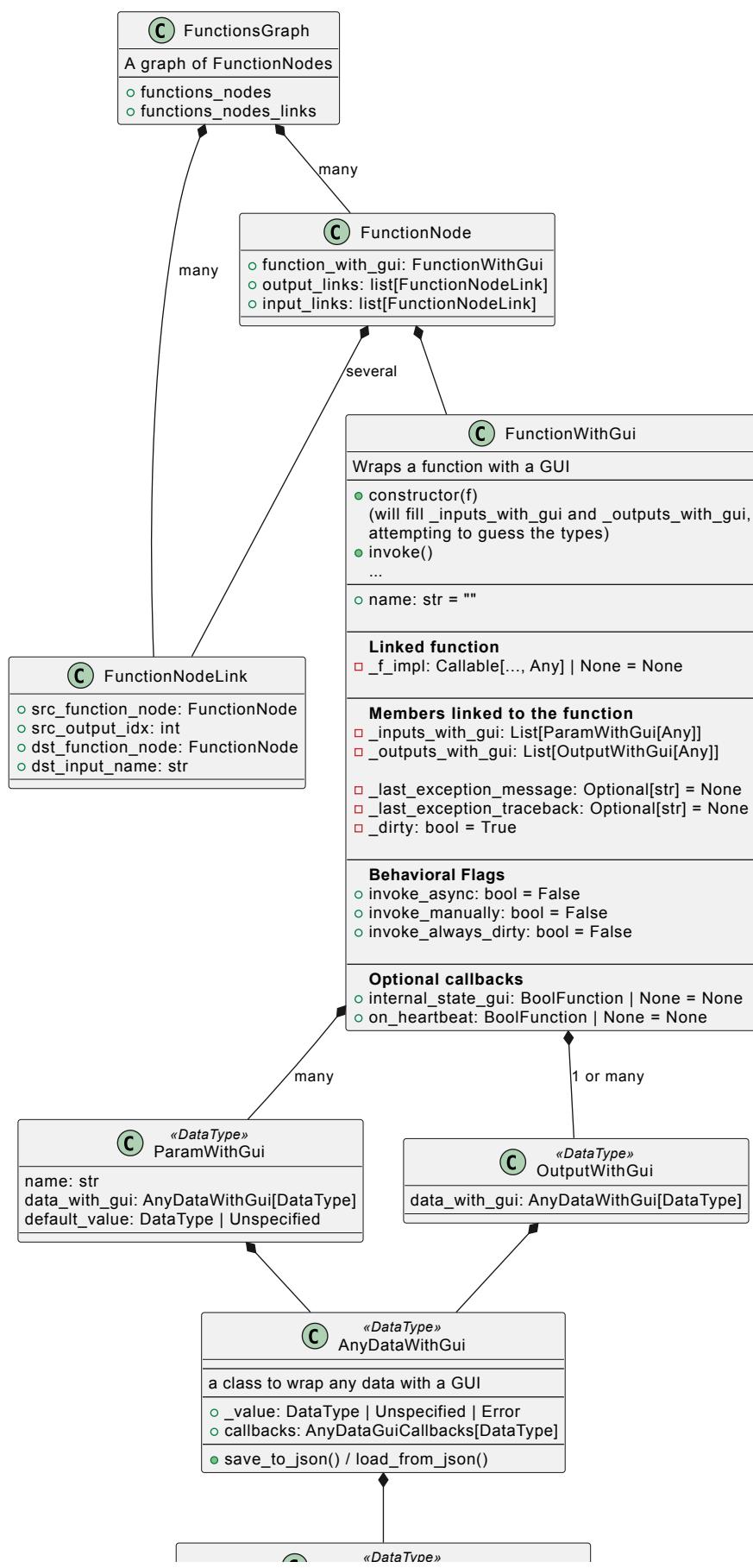
def \_\_init\_\_(self) -> None:  
 self.validate\_value = []

# Architecture

Below is a PlantUML diagram showing the architecture of the `fiat_core` module. See the [architecture page](#) for the full architecture diagrams.

```
from fiatlight.fiat_notebook import plantuml_magic
%plantuml_include class_diagrams/fiat_core.puml
```

## flat\_core



This is the core of fiatlight.  
It is a set of classes that can be used to add a GUI to any data, function or graph of functions.  
It does depend on ImGui, but not on imgui-node-editor.

| AnyDataGuiCallbacks   |
|---|
| a class that stores callbacks for AnyDataWithGui<br>(most of them are optional)                             |
| edit : BoolFunction (custom widgets for edition)<br>present_custom: VoidFunction (for presentation)<br>etc. |

# FunctionsGraph

**FunctionsGraph** is one of the core classes of FiatLight: it represents a graph of functions, where the output of one function can be linked to the input of another function.

- **Source:** see its full code [online](#)
- **Manual:** [FunctionsGraph API](#)

## Signature

Below, you will find the “signature” of the **FunctionsGraph** class, with its main attributes and methods (but not their bodies)

Its full source code is [!\[\]\(eb78d55b2f8ba643a351dd750205025d\_img.jpg\) available online](#).

```
from fiatlight.fiat_notebook import look_at_code
%look_at_class_header fiatlight.fiat_core.FunctionsGraph
```

```

class FunctionsGraph:
    """A graph of FunctionNodes

`FunctionsGraph` is one of the core classes of FiatLight: it represents a graph
where the output of one function can be linked to the input of another function.

See its [full code](../fiat_core/functions_graph.py).

It contains a graph of FunctionNodes modeled as a list of FunctionNode and a list
(which are the links between the outputs of a FunctionNode and the inputs of another).

This class only stores the data representation of the graph, and does not deal with
(for this, see FunctionGraphGui)

This class is not meant to be instantiated directly. Use the factory methods instead.

Public Members
=====
# the list of FunctionNode in the graph
functions_nodes: list[FunctionNode]
# the list of links between the FunctionNode
functions_nodes_links: list[FunctionNodeLink]

=====
functions_nodes: list[FunctionNode]
functions_nodes_links: list[FunctionNodeLink]
_secret_key: str = 'FunctionsGraph'

class _Construction_Section:
    """
    # =====
    #                                         Construction (Empty)
    # =====
    """

    pass

def __init__(self, secret_key: str='FunctionsGraph') -> None:
    """This class should not be instantiated directly. Use the factory methods instead.
    """
    pass

@staticmethod
def create_empty() -> 'FunctionsGraph':
    """Create an empty FunctionsGraph"""
    pass

class _Public_API_Add_Function_Section:
    """
    # =====
    #                                         Public API / Add functions
    # -----
    # Notes:
    #   You can add either Functions or FunctionWithGui
    """

```

```

#     - If f is a FunctionWithGui, it will be added as is
#     - If f is a standard function:
#         - it will be wrapped in a FunctionWithGui
#         - the function signature *must* mention the types of the parameters
# =====
"""
pass

@staticmethod
def from_function(f: Function | FunctionWithGui) -> 'FunctionsGraph':
    """Create a FunctionsGraph from a single function, either a standard function
    pass

@staticmethod
def from_function_composition(functions: Sequence[Function | FunctionWithGui]) -> 'FunctionsGraph':
    """Create a FunctionsGraph from a list of functions that will be chained together
    i.e. the output[0] of one function will be the input[0] of the next function
    """
    pass

def add_function_composition(self, functions: Sequence[Function | FunctionWithGui]):
    """Add a list of functions that will be chained together"""
    pass

def add_function(self, f: Function | FunctionWithGui) -> FunctionNode:
    """Add a function to the graph. It will not be linked to any other function.
    pass

def add_gui_node(self, gui_function: GuiFunctionWithInputs, label: str | None=None):
    pass

def add_task_node(self, task_function: GuiFunctionWithInputs, label: str | None=None):
    pass

def add_markdown_node(self, md_string: str, label: str='Documentation', text_wic:
    pass

class _Private_API_Add_Function_Section:
    """
    # =====
    #                                         Private API / Add functions
    # =====
    """
    pass

def _add_function_with_gui(self, f_gui: FunctionWithGui) -> FunctionNode:
    pass

def _add_function(self, f: Function) -> FunctionNode:
    pass

@staticmethod
def _create_from_function_composition(functions: Sequence[Function | FunctionWithGui]):
    """Create a FunctionsGraph from a list of PureFunctions([InputType] -> OutputType)
    """
    pass

```

```

* They should all be pure functions
* The output[0] of one should be the input[0] of the next
"""
pass

class _Graph_Manipulation_Section:
"""
# =====
#                               Graph manipulation
# =====
"""
pass

def _can_add_link(self, src_function_node: FunctionNode, dst_function_node: Func
    """Check if a link can be added between two functions. (private)"""
    pass

def _add_link_from_function_nodes(self, src_function_node: FunctionNode, dst_fur
    """Add a link between two functions nodes (private)"""
    pass

def add_link(self, src_function: str | Function | FunctionWithGui, dst_function:
    """Add a link between two functions, which are identified by their *unique*

    If a graph reuses several times the same function "f",
    the unique names for this functions will be "f_1", "f_2", "f_3", etc.
"""
    pass

def merge_graph(self, other: 'FunctionsGraph') -> None:
    """Merge another FunctionsGraph into this one"""
    pass

def function_with_gui_of_name(self, name: str | None=None) -> FunctionWithGui:
    """Get the function with the given unique name"""
    pass

def _would_add_cycle(self, new_link: FunctionNodeLink) -> bool:
    """Check if adding a link would create a cycle (private)"""
    pass

def has_cycle(self) -> bool:
    """Returns True if the graph has a cycle"""
    pass

def _has_cycle_from_node(self, fn: FunctionNode, path: Set[FunctionNode] | None=
    """Check if there is a cycle starting from a given node (private)"""
    pass

def _remove_link(self, link: FunctionNodeLink) -> None:
    """Remove a link between two functions (private)"""
    pass

def _remove_function_node(self, function_node: FunctionNode) -> None:

```

```

"""Remove a function node from the graph (private)"""
pass

class _Utilities_Section:
"""
# ===== Utilities =====
# ===== Utilities =====
"""
pass

def function_node_unique_name(self, function_node: FunctionNode) -> str:
    """Return the unique name of a function node:
    If a graph reuses several times the same function "f",
    the unique names for this functions will be "f_1", "f_2", "f_3", etc.
    """
    pass

def _function_node_with_name_or_is_function(self, name_or_function: str | FunctionNode) -> FunctionNode:
    """Get the function node with the given name or function"""
    pass

def _function_node_with_unique_name(self, function_name: str) -> FunctionNode:
    """Get the function with the unique name"""
    pass

def all_function_nodes_with_unique_names(self) -> Dict[str, FunctionNode]:
    """Return a dict of all the function nodes, with their unique names as keys"""
    pass

def shall_display_refresh_needed_label(self) -> bool:
    """Returns True if any function node shall display a "Refresh needed" label"""
    pass

class _Serialization_Section:
"""
# ===== Serialization =====
# Note: save_gui_options_to_json() and load_gui_options_from_json()
#       are intentionally not implemented here
#       See FunctionsGraphGui (which does deals with the GUI)
"""
pass

def save_user_inputs_to_json(self) -> JsonDict:
    """Saves the user inputs, i.e. the functions params that are editable in the
    (this excludes the params that are set by the links between the functions)"""
    pass

def load_user_inputs_from_json(self, json_data: JsonDict) -> None:
    """Restores the user inputs from a json dict"""
    pass

```

```
def save_graph_composition_to_json(self) -> JsonDict:
    """Saves the graph composition to a json dict.
    Only used when the graph composition is editable.
    """
    pass

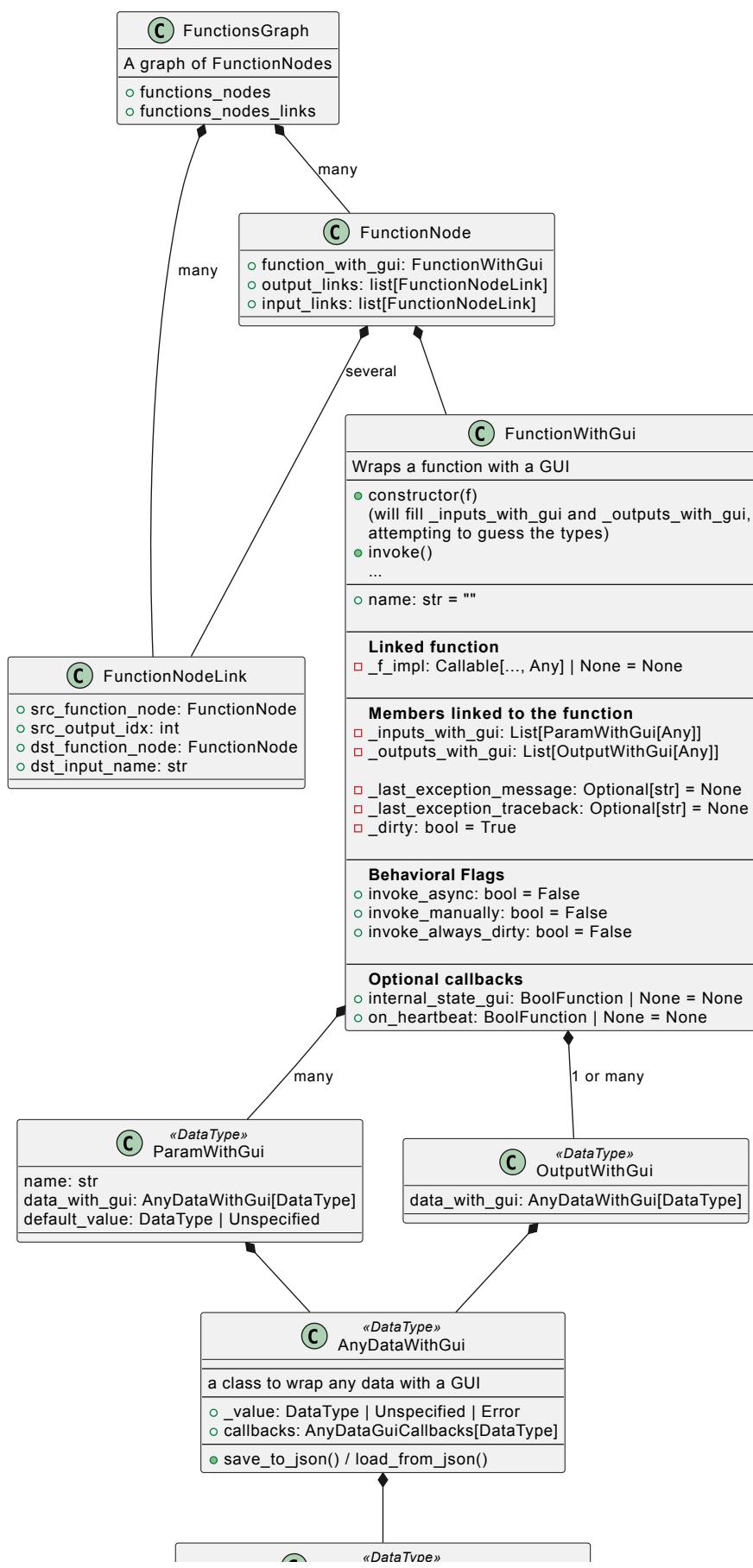
def load_graph_composition_from_json(self, json_data: JsonDict, function_factory):
    """Loads the graph composition from a json dict."""
    pass
```

## Architecture

Below is a PlantUML diagram showing the architecture of the `fiat_core` module. See the [architecture page](#) for the full architecture diagrams.

```
from fiatlight.fiat_notebook import plantuml_magic
%plantuml_include class_diagrams/fiat_core.puml
```

## flat\_core



This is the core of fiatlight.  
It is a set of classes that can be used to add a GUI to any data, function or graph of functions.  
It does depend on ImGui, but not on imgui-node-editor.

| AnyDataGuiCallbacks   |
|---|
| a class that stores callbacks for AnyDataWithGui<br>(most of them are optional)                             |
| edit : BoolFunction (custom widgets for edition)<br>present_custom: VoidFunction (for presentation)<br>etc. |

# Fiatlight Kits

Fiatlight offers several kits adapted to different domains.

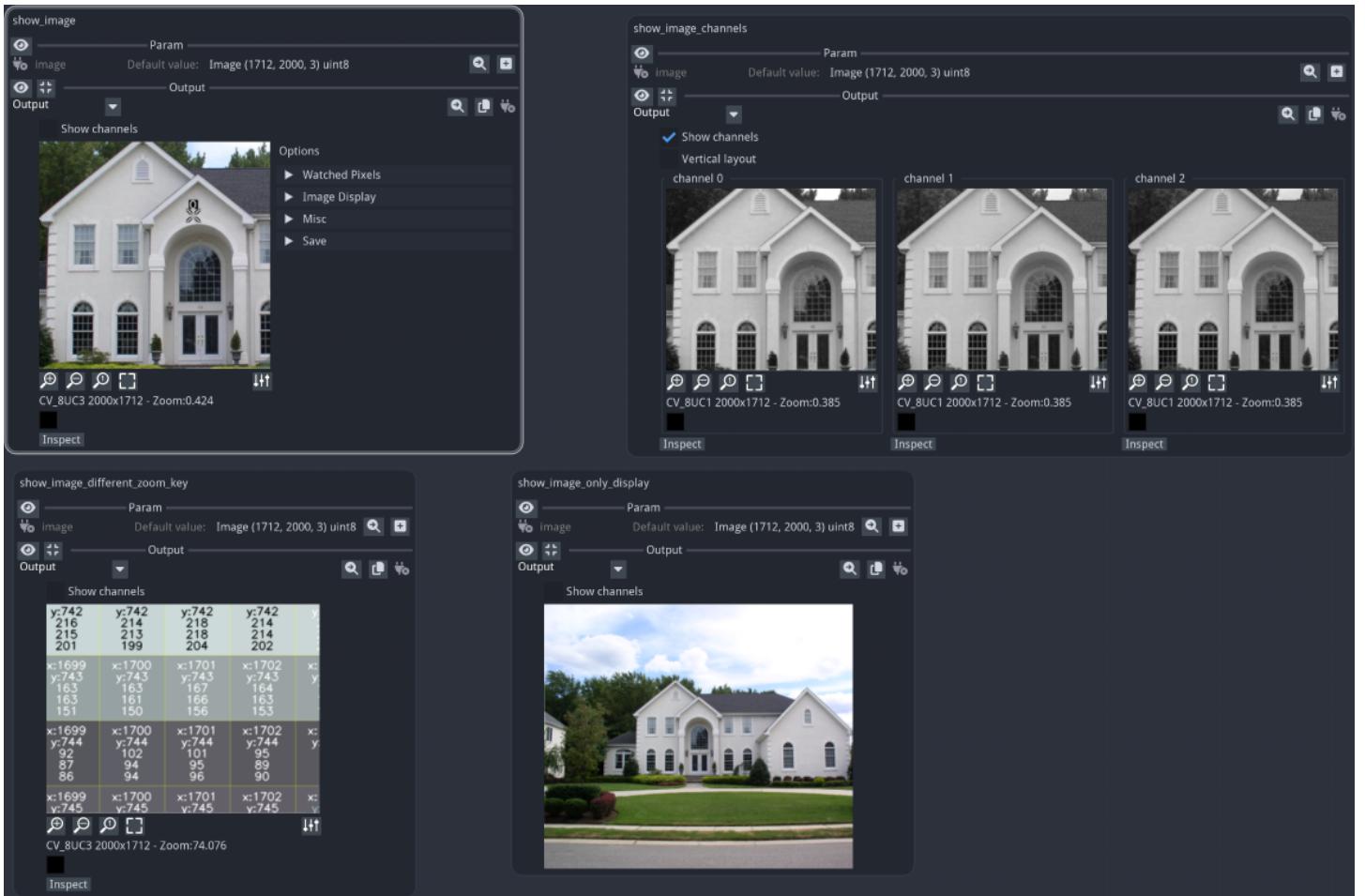
- [\*\*fiat\\_image\*\*](#): advanced image widget
- [\*\*fiat\\_matplotlib\*\*](#): widget to view matplotlib plots (zoomable)
- [\*\*fiat\\_dataframe\*\*](#): widget to explore pandas dataframes
- [\*\*fiat\\_implot\*\*](#): widget to explore 1D and 2D numpy arrays with [ImPlot](#)

## fiat\_image: advanced image widget

Fiatlight provides an advanced image viewer and analyzer which enables to zoom, pan, look at pixel values and sync the zoom across images.

### Example

```
from fiatlight.fiat_kits.fiat_image import fiat_image_attrs_demo
fiat_image_attrs_demo.main()
```



- In the “show\_image” output, the options panel was opened
- The “show\_image\_channels” output shows the image channels, and it zoom/pan is linked to “show\_image”
- The “show\_image\_different\_zoom\_key” image has a different zoom key, and the zoom/pan is not linked to “show\_image”. It also zoomed at a high-level, so that pixel values are displayed.
- the “show\_image\_only\_display” image is displayed, and cannot be zoomed or panned (the widget may be resized however)

## Fiat attributes available for the ImageWithGui widget

The image widget provided with fiat\_image is extremely customizable. Here is a list of all the possible customizations options:

```
%%bash  
flatlight gui ImageWithGui
```



GUI type: ImageWithGui

=====

A highly sophisticated GUI for displaying and analysing images. Zoom/Pan, show ch

Available custom attributes for fiat\_image.ImageWithGui:

| Name                            | Type            | Default  | Explanation   |
|---------------------------------|-----------------|----------|---|
| **Main attributes**             |                 |          |   |
| only_display                    | bool            | False    | Only display the zoom, no pan                       |
| Initial size of height). One of |                 |          |   |
| image_display_size              | tuple[int, int] | (200, 0) |   |
| zoom_key                        | str             | z        | Key to zoom in same zoom key w                      |
| is_color_order_bgr              | bool            | True     | Color order is BGR by default                       |
| can_resize                      | bool            | True     | Can resize the image with the bottom right corner   |
| **Channels**                    |                 |          |   |
| show_channels                   | bool            | False    | Show channels                                       |
| channel_layout_vertically       | bool            | False    | Layout channels vertically                          |
| **Zoom & Pan**                  |                 |          |   |
| pan_with_mouse                  | bool            | True     | Pan with mouse                                      |
| zoom_with_mouse_wheel           | bool            | True     | Zoom with mouse wheel                               |
| **Info displayed**              |                 |          |   |
| show_school_paper_background    | bool            | True     | Show school paper background when image is unzoomed |
| show_alpha_channel_checkerboard | bool            | True     | Show alpha channel checkerboard                     |
| show_grid                       | bool            | True     | Show grid with image                                |
| draw_values_on_zoomed_pixels    | bool            | True     | Draw values on zoomed pixels                        |
| **Info displayed**              |                 |          |   |
| show_image_info                 | bool            | True     | Show image info                                     |

|                           |                           |                           |                                  |
|---------------------------|---------------------------|---------------------------|----------------------------------|
| show_pixel_info           | bool                      | True                      | Show pixel info position under   |
|                           |                           |                           | **Control button**               |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+        |
| show_zoom_buttons         | bool                      | True                      | Show zoom buttons                |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+        |
| show_options_panel        | bool                      | True                      | Show options panel               |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+        |
| show_options_button       | bool                      | True                      | Show options button              |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+        |
| show_inspect_button       | bool                      | True                      | Show the inspect button          |
|                           |                           |                           | a large version of the Inspector |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+        |

Available custom attributes for AnyDataWithGui Generic attributes:

| Name                      | Type                      | Default  | Explanation   |
|---------------------------|---------------------------|--|---|
|                           |                           |  | **Generic attributes**  |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+                      | +-----+-----+-----+-----+   |
| validate_value            | object                    | None   | Function to validate a parameter. If None, return DataValidationResult.ok() |
|                           |                           |  |   |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+                      | +-----+-----+-----+-----+   |
| label                     | str                       |  | A label for the parameter. If empty, function parameter name is used        |
|                           |                           |  |   |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+                      | +-----+-----+-----+-----+   |
| tooltip                   | str                       |  | An optional tooltip to be displayed   |
|                           |                           |  |   |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+                      | +-----+-----+-----+-----+   |
| label_color               | ImVec4                    | ImVec4(0.000000, 0.000000, 0.000000, 1.000000) | The color of the label (will use text color if not provided)                |
|                           |                           |  |   |
| +-----+-----+-----+-----+ | +-----+-----+-----+-----+ | +-----+-----+-----+-----+                      | +-----+-----+-----+-----+   |

Code to test this GUI type:

```
```python
import typing
import fiatlight

@fiatlight.with_fiat_attributes(
    # Main attributes for the image viewer
    union_param_only_display = False,
    union_param_image_display_size = (200, 0),
    union_param_zoom_key = "z",
    union_param_is_color_order_bgr = True,
    union_param_can_resize = True,
    # Channels
    union_param_show_channels = False,
    union_param_channel_layout_vertically = False,
    # Zoom & Pan
    union_param_pan_with_mouse = True,
```

```

union_param__zoom_with_mouse_wheel = True,
# Info displayed on image
union_param__show_school_paper_background = True,
union_param__show_alpha_channel_checkerboard = True,
union_param__show_grid = True,
union_param__draw_values_on_zoomed_pixels = True,
# Info displayed under the image
union_param__show_image_info = True,
union_param__show_pixel_info = True,
# Control buttons under the image
union_param__show_zoom_buttons = True,
union_param__show_options_panel = True,
union_param__show_options_button = True,
union_param__show_inspect_button = True,
# Generic attributes
union_param__validate_value = None,
union_param__label = "",
union_param__tooltip = "",
union_param__label_color = ImVec4(0.000000, 0.000000, 0.000000, 1.000000)
def f(union_param: typing.Union[flatlight.flat_kits.flat_image.image_types.ImageU8_]:
    return union_param

flatlight.run(f)
```

```

## Image types

Fiatlight provides several synonyms for Numpy arrays that denote different types of images. Each of these types will be displayed by the image widget.

```

import fiatlight
from fiatlight.flat_notebook import look_at_code
%look_at_python_file fiat_kits fiat_image image_types.py

```

"""This module defines several types you can use to annotate your functions.  
The image types are defined as NewType instances, which are just aliases for numpy arrays.  
All those types will be displayed in the GUI as images, using the ImmVision image viewer  
(<https://github.com/pthom/immvision>)

#### Notes:

- The easiest way to display an image is to use the `Image` type, which is a union of all UInt8 image types.
- any numpy array can be used to create an `Image`, and the viewer will try to convert it.

```
from typing import Any, NewType
import numpy as np
from typing import Tuple, Union

# Define shape types for clarity
ShapeHeightWidth = Tuple[int, int]
ShapeHeightWidthChannels = Tuple[int, int, int]

# Define UInt8 as a dtype for numpy arrays
UInt8 = np.dtype[np.uint8]
AnyFloat = np.dtype[np.floating[Any]]

# 
# UInt8 Images
#
# ImageU8 = NewType("ImageU8", np.ndarray[ShapeHeightWidthChannels | ShapeHeightWidth])
# Type definitions for UInt8 images based on channel count
ImageU8_1 = NewType("ImageU8_1", np.ndarray[ShapeHeightWidth, UInt8])
ImageU8_2 = NewType("ImageU8_2", np.ndarray[ShapeHeightWidthChannels, UInt8])
ImageU8_3 = NewType("ImageU8_3", np.ndarray[ShapeHeightWidthChannels, UInt8])
ImageU8_4 = NewType("ImageU8_4", np.ndarray[ShapeHeightWidthChannels, UInt8])
ImageU8_WithNbChannels = Union[ImageU8_1, ImageU8_2, ImageU8_3, ImageU8_4]
# Type definitions based on the roles of the channels
ImageU8_RGB = NewType("ImageU8_RGB", ImageU8_3)
ImageU8_RGBA = NewType("ImageU8_RGBA", ImageU8_4)
ImageU8_BGRA = NewType("ImageU8_BGRA", ImageU8_4)
ImageU8_BGR = NewType("ImageU8_BGR", ImageU8_3)
ImageU8_GRAY = NewType("ImageU8_GRAY", ImageU8_1)
ImageU8_WithChannelsRoles = Union[ImageU8_RGB, ImageU8_RGBA, ImageU8_BGRA, ImageU8_BGR, ImageU8_GRAY]

# Generic type for any 8-bit image
ImageU8 = Union[ImageU8_WithNbChannels, ImageU8_WithChannelsRoles]

# 
# Float Images
#
# Type definitions for float images based on channel count
ImageFloat_1 = NewType("ImageFloat_1", np.ndarray[ShapeHeightWidth, AnyFloat])
ImageFloat_2 = NewType("ImageFloat_2", np.ndarray[ShapeHeightWidthChannels, AnyFloat])
```

```

ImageFloat_3 = NewType("ImageFloat_3", np.ndarray[ShapeHeightWidthChannels, AnyFloat])
ImageFloat_4 = NewType("ImageFloat_4", np.ndarray[ShapeHeightWidthChannels, AnyFloat])

# Generic type for any float image
ImageFloat = Union[ImageFloat_1, ImageFloat_2, ImageFloat_3, ImageFloat_4]

#
# Generic Image Type
#
# Image is a union of all image types
Image = Union[ImageU8, ImageFloat]

# ----- Register image type factories -----

def _register_image_type_factories() -> None:
    from fiatlight.fiat_togui.gui_registry import gui_factories
    from fiatlight.fiat_kits.fiat_image.image_gui import ImageWithGui

    prefix = "fiatlight.fiat_kits.fiat_image.image_types.Image"
    gui_factories().register_factory_name_start_with(prefix, ImageWithGui)
    gui_factories().register_factory_union(prefix, ImageWithGui)

```

## Source code for the example

```
%look_at_python_file fiat_kits/fiat_image/fiat_image_attrs_demo.py
```

```
"""Demo how to set custom presentation attributes for the Image Widget (ImageWithGu
```

#### Notes:

- The custom attributes can be set using the decorator `fl.with_fiat_attributes`
  - In these examples, we intend to set custom attributes for the output of the functions, i.e. the returned value.
- As a consequence, the custom attributes are set in the `return_...` arguments of the decorator.

```
....
```

```
import fiatlight as fl
from fiatlight.fiat_kits.fiat_image import ImageU8_3
import cv2

# Our demo image
demo_image: ImageU8_3 = cv2.imread(fl.demo_assets_dir() + "/images/house.jpg") # t

# A simple function that will use the Image Widget with its default settings.
def show_image(image: ImageU8_3 = demo_image) -> ImageU8_3:
    return image

# A function whose output will initially show the channels
# Since it does not specify a zoom key,
# it will be zoomed and panned together with the image
# shown by "show_image"
@fl.with_fiat_attributes(return__show_channels=True)
def show_image_channels(image: ImageU8_3 = demo_image) -> ImageU8_3:
    return image

# A function whose output will have a different zoom key:
# it can be panned and zoomed, independently of the other images
@fl.with_fiat_attributes(return__zoom_key="other")
def show_image_different_zoom_key(image: ImageU8_3 = demo_image) -> ImageU8_3:
    return image

# A function that will use the Image Widget with custom attributes:
# - the image is displayed only (it cannot be zoomed or panned,
#   and the pixel values are not shown)
# - the image is displayed with a height of 300 pixels
#   (the width is automatically calculated)
# - the image cannot be resized
@fl.with_fiat_attributes(
    return__only_display=True,
    return__image_display_size=(0, 300),
    return__can_resize=False,
)
def show_image_only_display(image: ImageU8_3 = demo_image) -> ImageU8_3:
    return image
```

```

def main() -> None:
    graph = fl.FunctionsGraph()
    graph.add_function(show_image)
    graph.add_function(show_image_channels)
    graph.add_function(show_image_different_zoom_key)
    graph.add_function(show_image_only_display)

    fl.run(graph, app_name="fiat_image_fiat_attrs_demo")

if __name__ == "__main__":
    main()

```

## fiat\_matplotlib: display matplotlib figures

Fiatlight provides [FigureWithGui](#), a viewer for Matplotlib figures.

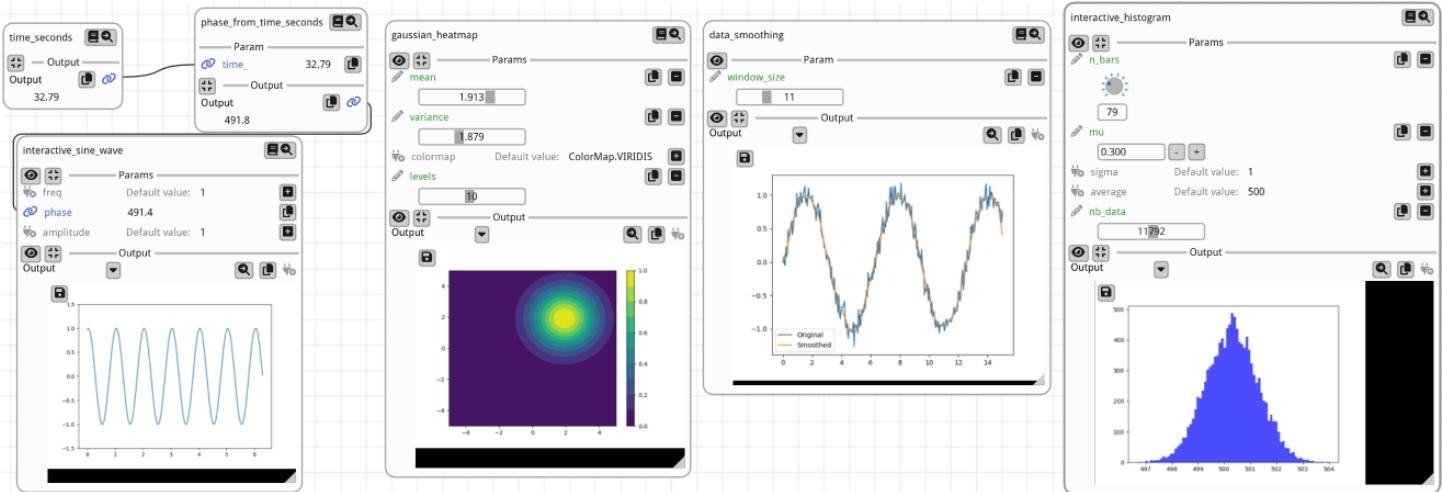
### Example

```

from fiatlight.fiat_kits.fiat_matplotlib import demo_matplotlib

demo_matplotlib.main()

```



## Fiat attributes available for the FigureWithGui widget

The FigureWithGui widget is not customizable. However, it can be zoomed by the user and this setting will be saved.

## Source code for the example

```
import fiatlight
from fiatlight.fiat_notebook import look_at_code # noqa
%look_at_python_file fiat_kits/fiat_matplotlib/demo_matplotlib.py
```

## """Interactive Matplotlib Figures with Fiatlight

This example demonstrates several types of matplotlib figures rendered within Fiatlight.

```
import matplotlib.pyplot as plt
from matplotlib.figure import Figure
import numpy as np
from enum import Enum
import time
import fiatlight as fl

# Initialize the start time
_start_time = time.time()

def time_seconds() -> float:
    """Returns the time elapsed since the start of the application."""
    return time.time() - _start_time

def phase_from_time_seconds(time_: float) -> float:
    """Calculates the phase from the given time."""
    return time_ * 15.0

# Set the function to always update
time_seconds.invoke_always_dirty = True # type: ignore

def interactive_sine_wave(freq: float = 1.0, phase: float = 0.0, amplitude: float =
    """Generates an interactive sine wave with adjustable frequency, phase, and amplitude."""
    x = np.linspace(0, 2 * np.pi, 3000)
    y = amplitude * np.sin(2 * np.pi * freq * x + phase)
    fig, ax = plt.subplots()
    ax.plot(x, y)
    ax.set_ylim([-1.5, 1.5]) # Adjust the y-axis limits
    return fig

# Set ranges and edit types for the sine wave parameters
fl.add_fiat_attributes(
    interactive_sine_wave,
    freq_range=(0.1, 3),
    phase_range=(-np.pi, np.pi),
    amplitude_range=(0.1, 2),
    freq_edit_type="knob",
    phase_edit_type="knob",
    amplitude_edit_type="knob",
)
```

```

class ColorMap(Enum):
    VIRIDIS = "viridis"
    PLASMA = "plasma"
    INFERNO = "inferno"
    MAGMA = "magma"
    CIVIDIS = "cividis"

@fl.with_fiat_attributes(
    mean_range=(-5, 5),
    variance_range=(0.1, 5),
    levels_range=(1, 20),
)
def gaussian_heatmap(
    mean: float = 0, variance: float = 1, colormap: ColorMap = ColorMap.VIRIDIS, levels: int = 20
) -> Figure:
    """Generates a Gaussian heatmap with adjustable mean, variance, colormap, and number of levels"""
    x = y = np.linspace(-5, 5, 100)
    X, Y = np.meshgrid(x, y)
    Z = np.exp(-(X - mean) ** 2 + (Y - mean) ** 2) / (2 * variance)
    fig, ax = plt.subplots()
    contour = ax.contourf(X, Y, Z, levels, cmap=colormap.value)
    fig.colorbar(contour, ax=ax)
    return fig

@fl.with_fiat_attributes(window_size_range=(1, 40))
def data_smoothing(window_size: int = 5) -> Figure:
    """Demonstrates data smoothing using a moving average filter."""
    x = np.linspace(0, 15, 300)
    y = np.sin(x) + np.random.normal(0, 0.1, 300) # Noisy sine wave
    y_smooth = np.convolve(y, np.ones(window_size) / window_size, mode="same")
    fig, ax = plt.subplots()
    ax.plot(x, y, label="Original")
    ax.plot(x, y_smooth, label="Smoothed")
    ax.legend()
    return fig

def interactive_histogram(
    n_bars: int = 10, mu: float = 0, sigma: float = 1, average: float = 500, nb_data: int = 1000
) -> Figure:
    """Generates an interactive histogram with adjustable number of bars, mean, and average"""
    data = np.random.normal(mu, sigma, int(nb_data)) + average
    bins = np.linspace(np.min(data), np.max(data), n_bars)
    fig, ax = plt.subplots()
    ax.hist(data, bins=bins, color="blue", alpha=0.7)
    return fig

# Set interactive parameters for the histogram
fl.add_fiat_attributes(
    interactive_histogram,
    n_bars_edit_type="knob",
)

```

```

n_bars__range=(1, 300),
mu__edit_type="input",
mu__range=(-5, 5),
sigma__edit_type="drag",
sigma__range=(0.1, 5),
average__edit_type="slider_float_any_range",
nb_data__edit_type="slider",
nb_data__range=(100, 1_000_000),
nb_data__slider_logarithmic=True,
nb_data__slider_no_input=True,
)

def main() -> None:
    """Main function to run the Fiatlight application with interactive matplotlib figures"""
    import fiatlight

    # Create a graph to manage functions and their links
    graph = fiatlight.FunctionsGraph()
    graph.add_function(interactive_sine_wave)
    graph.add_function(gaussian_heatmap)
    graph.add_function(data_smoothing)
    graph.add_function(interactive_histogram)
    graph.add_function(time_seconds)
    graph.add_function(phase_from_time_seconds)
    graph.add_link("time_seconds", "phase_from_time_seconds", "time_")
    graph.add_link("phase_from_time_seconds", "interactive_sine_wave", "phase")
    fiatlight.run(graph, app_name="figure_with_gui_demo")

if __name__ == "__main__":
    main()

```

## fiat\_dataframe: pandas DataFrame explorer

Fiatlight provides `DataFrameWithGui`, a viewer for pandas dataframes that allows to sort, and visualize the data. Composed with the advanced GUI creation capabilities of fiatlight, it can also filter data.

### Example

```

from fiatlight.fiat_kits.fiat_dataframe import dataframe_with_gui_demo_titanic
dataframe_with_gui_demo_titanic.main()

```

show\_titanic\_db

| Params                                |            |  |                  |        |      |       |       |               |         |       |    |  |  |                |                                   |
|---------------------------------------|------------|--|------------------|--------|------|-------|-------|---------------|---------|-------|----|--|--|----------------|-----------------------------------|
|                                       | name_query | <input type="text"/>                               |                  |        |      |       |       |               |         |       |    |  |  |                |                                   |
|                                       | sex_query  | Optional: None <input type="button" value="Set"/>  |                  |        |      |       |       |               |         |       |    |  |  |                |                                   |
|                                       | age_min    | Optional: None <input type="button" value="Set"/>  |                  |        |      |       |       |               |         |       |    |  |  |                |                                   |
|                                       | age_max    | Optional: Set <input type="button" value="Unset"/> |                  |        |      |       |       |               |         |       |    |  |  |                |                                   |
| <input type="button" value="10"/>     |            |  |                  |        |      |       |       |               |         |       |    |  |  |                |                                   |
| Output                                |            |  |                  |        |      |       |       |               |         |       |    |  |  |                |                                   |
| <input type="button" value="Output"/> |            |  |                  |        |      |       |       |               |         |       |    |  |  |                |                                   |
| <input type="button" value="1 / 7"/>  |            |  |                  |        |      |       |       |               |         |       |    |  |  | Rows per page: | <input type="button" value="10"/> |
| PassengerId                           | Survived   | Pclass   | Name             | Sex    | Age  | SibSp | Parch | Ticket        | Fare    | Cabin | Em |  |  |                |                                   |
| 8                                     | 0          | 3  | Palsson, Master. | male   | 2.0  | 3     | 1     | 349909        | 21.075  | nan   | S  |  |  |                |                                   |
| 11                                    | 1          | 3  | Sandstrom, M.    | female | 4.0  | 1     | 1     | PP 9549       | 16.7    | G6    | S  |  |  |                |                                   |
| 17                                    | 0          | 3  | Rice, Master.    | male   | 2.0  | 4     | 1     | 382652        | 29.125  | nan   | Q  |  |  |                |                                   |
| 25                                    | 0          | 3  | Palsson, Miss.   | female | 8.0  | 3     | 1     | 349909        | 21.075  | nan   | S  |  |  |                |                                   |
| 44                                    | 1          | 2  | Laroche, Miss.   | female | 3.0  | 1     | 2     | SC/Paris 2123 | 41.5792 | nan   | C  |  |  |                |                                   |
| 51                                    | 0          | 3  | Panula, Master.  | male   | 7.0  | 4     | 1     | 3101295       | 39.6875 | nan   | S  |  |  |                |                                   |
| 59                                    | 1          | 2  | West, Miss. C.   | female | 5.0  | 1     | 2     | C.A. 34651    | 27.75   | nan   | S  |  |  |                |                                   |
| 64                                    | 0          | 3  | Skoog, Master.   | male   | 4.0  | 3     | 2     | 347088        | 27.9    | nan   | S  |  |  |                |                                   |
| 79                                    | 1          | 2  | Caldwell, Mrs.   | male   | 0.83 | 0     | 2     | 248738        | 29.0    | nan   | S  |  |  |                |                                   |
| 120                                   | 0          | 3  | Andersson, Mr.   | female | 2.0  | 4     | 2     | 347082        | 31.275  | nan   | S  |  |  |                |                                   |

By clicking on the magnifier button  on top of the dataframe, you can open it in a popup where sorting options are available. Click on one column (or shift-click on multiple columns) to sort the data.

```
dataframe_with_gui_demo_titanic.main()
```

show\_titanic\_db

Params

name\_query

sex\_query Optional: None Set

age\_min Optional: None Set

age\_max Optional: Set Unset 10

Output

Output - show\_titanic\_db (View)

Rows per page: 10

| Passe... | Surviv... | Pc... | Name         | Sex    | Age  | SibSp | Parch | Ticket        | Fare    | Cabin   |
|----------|-----------|-------|--------------|--------|------|-------|-------|---------------|---------|---------|
| 804      | 1         | 3     | Thomas, M    | male   | 0.42 | 0     | 1     | 2625          | 8.5167  | nan     |
| 756      | 1         | 2     | Hamalaine    | male   | 0.67 | 1     | 1     | 250649        | 14.5    | nan     |
| 645      | 1         | 3     | Baclini, Mis | female | 0.75 | 2     | 1     | 2666          | 19.2583 | nan     |
| 470      | 1         | 3     | Baclini, Mis | female | 0.75 | 2     | 1     | 2666          | 19.2583 | nan     |
| 79       | 1         | 2     | Caldwell, M  | male   | 0.83 | 0     | 2     | 248738        | 29.0    | nan     |
| 832      | 1         | 2     | Richards, M  | male   | 0.83 | 1     | 1     | 29106         | 18.75   | nan     |
| 306      | 1         | 1     | Allison, Ma  | male   | 0.92 | 1     | 2     | 113781        | 151.55  | C22 C26 |
| 184      | 1         | 2     | Becker, Ma   | male   | 1.0  | 2     | 1     | 230136        | 39.0    | F4      |
| 789      | 1         | 3     | Dean, Mast   | male   | 1.0  | 1     | 2     | C.A. 2315     | 20.575  | nan     |
| 387      | 0         | 3     | Goodwin, M   | male   | 1.0  | 5     | 2     | CA 2144       | 46.9    | nan     |
| 173      | 1         | 3     | Johnson, M   | female | 1.0  | 1     | 1     | 347742        | 11.1333 | nan     |
| 828      | 1         | 2     | Mallet, Ma   | male   | 1.0  | 0     | 2     | S.C./PARIS 20 | 37.0042 | nan     |
| 382      | 1         | 3     | Nakid, Mis   | female | 1.0  | 0     | 2     | 2653          | 15.7417 | nan     |
| 165      | 0         | 3     | Panula, Ma   | male   | 1.0  | 4     | 1     | 3101295       | 39.6875 | nan     |
| 298      | 0         | 1     | Allison, Mis | female | 2.0  | 1     | 2     | 113781        | 151.55  | C22 C26 |
| 120      | 0         | 2     | Anderseen    | female | 2.0  | 4     | 2     | 247092        | 21.275  | nan     |

## Fiat attributes available for DataFrameWithGui

Here is a list of all the possible customizations options:

```
%%bash
fiatlight gui DataFrameWithGui
```



GUI type: DataFrameWithGui

---

A class to present a pandas DataFrame in the GUI, with pagination and other features.

Available custom attributes for DataFrameWithGui:

---

| Name                   | Type                | Default      | Explanation                                    |
|------------------------|---------------------|--------------|--|
| widget_size_em         | tuple[float, float] | (50.0, 15.0) | Widget size in em                              |
| column_widths_em       | dict                | {}           | Dictionary to specify individual column widths |
| rows_per_page_node     | int                 | 10           | Number of rows to be displayed in a full node  |
| rows_per_page_classic  | int                 | 20           | Number of rows to be displayed in a pop-up     |
| current_page_start_idx | int                 | 0            | Index of the first row used for pagination     |

Available custom attributes for AnyDataWithGui Generic attributes:

---

| Name           | Type   | Default  | Explanation   |
|----------------|--------|--|---|
|                |        |  | **Generic attributes**  |
| validate_value | object | None   | Function to validate a parameter. It will return DataValidationResult.ok() if valid or DataValidationResult.error() if invalid. |
| label          | str    |  | A label for the parameter. If empty, the function parameter name is used.   |
| tooltip        | str    |  | An optional tooltip to be displayed when hovering over the parameter.   |
| label_color    | ImVec4 | ImVec4(0.000000, 0.000000, 0.000000, 1.000000) | The color of the label (will use text color if not provided).   |

Code to test this GUI type:

---

```
```python
import typing
import fiatlight

@fiatlight.with_fiat_attributes()
dataframe_param_widget_size_em = (50.0, 15.0),
dataframe_param_column_widths_em = {},
```

```
dataframe_param__rows_per_page_node = 10,
dataframe_param__rows_per_page_classic = 20,
dataframe_param__current_page_start_idx = 0,
# Generic attributes
dataframe_param__validate_value = None,
dataframe_param__label = "",
dataframe_param__tooltip = "",
dataframe_param__label_color = ImVec4(0.000000, 0.000000, 0.000000, 1.000000)
def f(dataframe_param: pandas.core.frame.DataFrame) -> pandas.core.frame.DataFrame:
    return dataframe_param

fiatlight.run(f)
```
```

## Source code for the example

```
import fiatlight
from fiatlight.fiat_notebook import look_at_code # noqa
%look_at_python_file fiat_kits/fiat_dataframe/dataframe_with_gui_demo_titanic.py
```

```

import fiatlight as fl
import pandas as pd
from enum import Enum

def make_titanic_df() -> pd.DataFrame:
    # Here, we provide an example data frame to the user,
    # using the Titanic dataset from the Data Science Dojo repository.
    # (widely used in data science tutorials)
    url = "https://raw.githubusercontent.com/datasets/master/titanic.csv"
    try:
        df = pd.read_csv(url)
    except Exception as e:
        print(f"Error loading sample dataset: {e}")
        df = pd.DataFrame() # Return an empty DataFrame in case of failure
    return df

class Sex(Enum):
    Man = "male"
    Woman = "female"

@fl.with_fiat_attributes(
    # define the custom attributes for the function parameters
    age_min_range=(0, 100),
    age_max_range=(0, 100),
    # define custom attributes for the function output
    # (i.e. the presentation options for the DataFrame)
    return_widget_size_em=(55.0, 15.0),
    return_rows_per_page_node=10,
    return_rows_per_page_popup=20,
    return_column_widths_em={"Name": 5},
)
def show_titanic_db(
    name_query: str = "", sex_query: Sex | None = None, age_min: int | None = None,
) -> pd.DataFrame:
    dataframe = make_titanic_df()
    if dataframe.empty:
        return dataframe

    # filter dataframe
    if name_query:
        dataframe = dataframe[dataframe["Name"].str.contains(name_query, case=False)]
    if sex_query:
        dataframe = dataframe[dataframe["Sex"] == sex_query.value]
    if age_min is not None:
        dataframe = dataframe[dataframe["Age"] >= age_min]
    if age_max is not None:
        dataframe = dataframe[dataframe["Age"] <= age_max]

    return dataframe

```

```
def main() -> None:
    fl.run(show_titanic_db, app_name="dataframe_with_gui_demo_titanic")

if __name__ == "__main__":
    main()
```

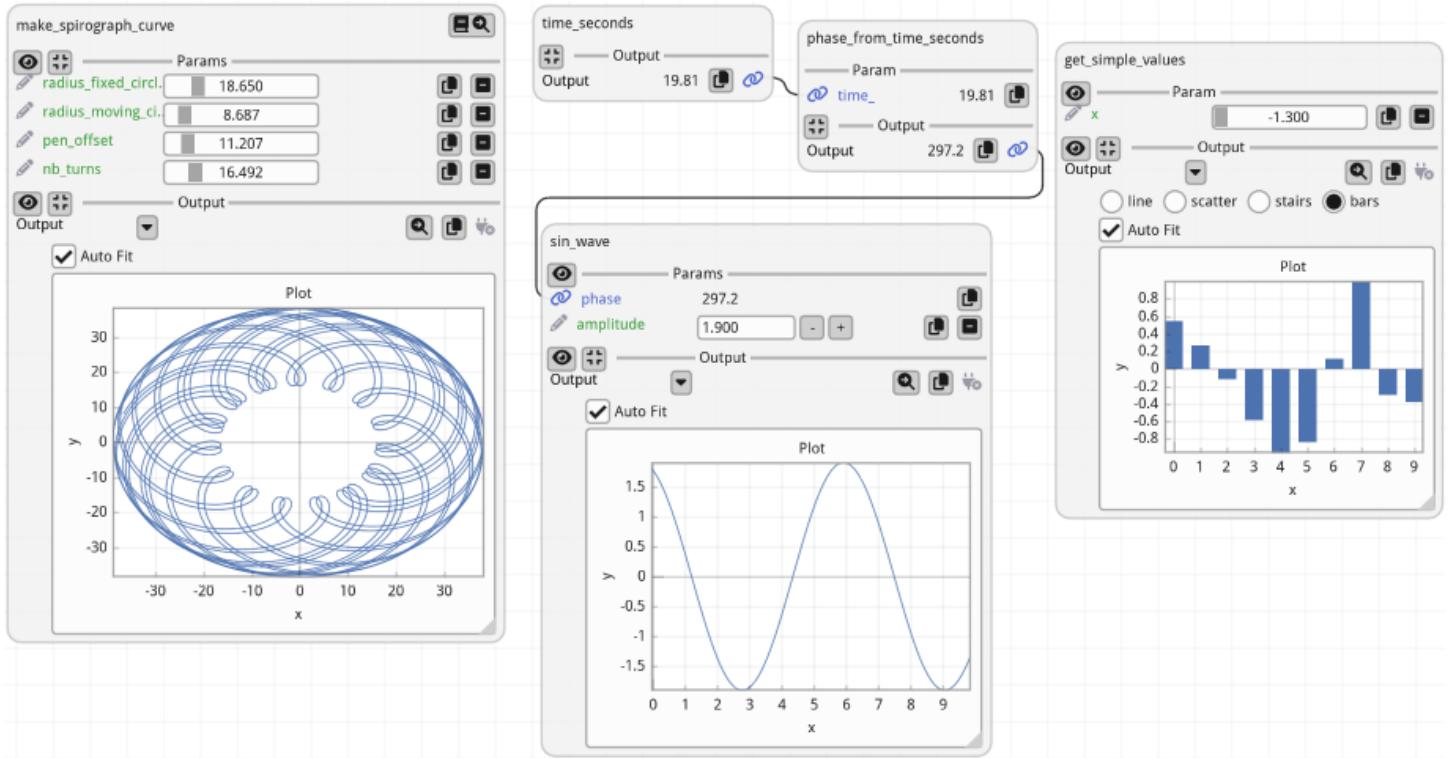
## fiat\_implot: widget for 1D and 2D numpy arrays

Fiatlight provides [SimplePlotGui](#), a viewer for numpy arrays that allows to plot 1D and 2D arrays with [ImPlot](#)

- ImPlot is a very capable and fast plotting library, not limited to simple 1D and 2D plots. It is available with Fiatlight and ImGui Bundle (on which Fiatlight is based). See [online demo](#) of ImPlot for more examples.
- It is faster than Matplotlib within Fiatlight, and well adapted for real time plots (can refresh at 120FPS +)

## Example

```
from fiatlight.fiat_kits.fiat_implot import demo_implot
demo_implot.main()
```



## Fiat attributes available for SimplePlotGui

Here is a list of all the type handled by SimplePlotGui:

```
%%bash
fiatlight types FloatMatrix_Dim
```

| Data Type  | Gui Type   |
|--|--|
| fiatlight.fiat_kits.fiat_implot.array_types.FloatMatrix_Dim  | fiatlight.fiat_kits.fiat_implot.array_types.FloatMatrix_Dim<br>A GUI for presenting 1D or array as a line, scatter (+ small enough)  |
| fiatlight.fiat_kits.fiat_implot.array_types.FloatMatrix_Dim2 | fiatlight.fiat_kits.fiat_implot.array_types.FloatMatrix_Dim2<br>A GUI for presenting 1D or array as a line, scatter (+ small enough) |

Here is a list of all the possible customizations options:

```
%%bash  
fiatlight gui SimplePlotGui
```



GUI type: SimplePlotGui

=====

A GUI for presenting 1D or 2D arrays with ImPlot. Can present the array as a line

Available custom attributes for SimplePlotGui:

| Name                  | Type                | Default      | Explanation                                  |
|-----------------------|---------------------|--------------|--|
| plot_type             | str                 | line         | The type of presentation: line, scatter, sta |
| plot_size_em          | tuple[float, float] | (35.0, 20.0) | Size in em units (width, height)             |
| auto_fit              | bool                | True         | Auto-scale the plot                          |
| small_array_threshold | int                 | 100          | The threshold for present scatter, ba        |

Available custom attributes for AnyDataWithGui Generic attributes:

| Name           | Type   | Default  | Explanation   |
|----------------|--------|--|---|
|                |        |  | **Generic attributes**  |
| validate_value | object | None   | Function to validate a parameter. If None, return DataValidationResult.ok() |
| label          | str    |  | A label for the parameter. If empty, function parameter name is used        |
| tooltip        | str    |  | An optional tooltip to be displayed   |
| label_color    | ImVec4 | ImVec4(0.000000, 0.000000, 0.000000, 1.000000) | The color of the label (will use text color if not provided)                |

Code to test this GUI type:

```
```python
import typing
import fiatlight

@fiatlight.with_fiat_attributes(
    floatmatrix_param__plot_type = "line",
    floatmatrix_param__plot_size_em = (35.0, 20.0),
    floatmatrix_param__auto_fit = True,
    floatmatrix_param__small_array_threshold = 100,
    # Generic attributes
```

```
floatmatrix_param__validate_value = None,  
floatmatrix_param__label = "",  
floatmatrix_param__tooltip = "",  
floatmatrix_param__label_color = ImVec4(0.000000, 0.000000, 0.000000, 1.000000)  
def f(floatmatrix_param: fiatlight.fiat_kits.fiat_implot.array_types.FloatMatrix) ->  
    return floatmatrix_param  
  
fiatlight.run(f)  
```
```

## Source code for the example

```
import fiatlight  
from fiatlight.fiat_notebook import look_at_code # noqa  
%look_at_python_file fiat_kits/fiat_implot/demo_implot.py
```

```
"""Demonstrates plots generated using ImPlot (https://github.com/epezent/implot). In  
This example demonstrates  
- how to create a live sine wave plot with adjustable frequency, phase, and amplitude.  
    The frequency, phase, and amplitude can be adjusted interactively using knobs.  
- how to create a spirograph-like curve using ImPlot.  
"""
```

```
from fiatlight import fiat_implot  
import fiatlight as fl  
import numpy as np  
import math  
import time  
  
_start_time = time.time()  
  
def time_seconds() -> float:  
    return time.time() - _start_time  
  
def phase_from_time_seconds(time_: float) -> float:  
    return time_ * 15.0  
  
time_seconds.invoke_always_dirty = True # type: ignore  
  
def sin_wave(phase: float, amplitude: float = 1.0) -> fiat_implot.FloatMatrix_Dim2:  
    x = np.arange(0, 10, 0.1)  
    y = np.sin(x + phase) * amplitude  
    r = np.stack((x, y))  
    return r # type: ignore  
  
@fl.with_fiat_attributes(  
    radius_fixed_circle_range=(0.0, 100.0),  
    radius_moving_circle_range=(0.0, 100.0),  
    pen_offset_range=(0.0, 100.0),  
    nb_turns_range=(0.0, 100.0),  
)  
def make_spirograph_curve(  
    radius_fixed_circle: float = 10.84,  
    radius_moving_circle: float = 3.48,  
    pen_offset: float = 6.0,  
    nb_turns: float = 23.0,  
) -> fiat_implot.FloatMatrix_Dim2:  
    """A spirograph-like curve"""  
    import numpy as np  
  
    t = np.linspace(0, 2 * np.pi * nb_turns, int(500 * nb_turns))  
    x = (radius_fixed_circle + radius_moving_circle) * np.cos(t) - pen_offset * np.sin(t)  
    y = (radius_fixed_circle + radius_moving_circle) / radius_moving_circle * t
```

```

)
y = (radius_fixed_circle + radius_moving_circle) * np.sin(t) - pen_offset * np.sin((radius_fixed_circle + radius_moving_circle) / radius_moving_circle * t)
)
return np.array([x, y]) # type: ignore

@fl.with_fiat_attributes(
    x_range=(0.0, 10.0),
    return_plot_type="bars",
    return_auto_fit=False,
    return_plot_size_em=(20, 10),
)
def get_simple_values(x: float) -> fiat_implot.FloatMatrix_Dim1:
    r = []
    for i in range(10):
        r.append(math.cos(x*i))
    return np.array(r) # type: ignore

def main() -> None:
    graph = fl.FunctionsGraph()
    graph.add_function(make_spirograph_curve)
    graph.add_function(get_simple_values)

    graph.add_function(time_seconds)
    graph.add_function(phase_from_time_seconds)
    graph.add_function(sin_wave)
    graph.add_link("time_seconds", "phase_from_time_seconds")
    graph.add_link("phase_from_time_seconds", "sin_wave")

    fl.run(graph, app_name="Demo ImPlot")

if __name__ == "__main__":
    main()

```

## Comparisons w. other frameworks

An extensive comparison of Fiatlight [with streamlit](#), [with dash](#), and [with ipywidgets](#) is available in the subsections.

## Comparison with Streamlit

This page provides a detailed comparison between Fiatlight and Streamlit, highlighting the strengths and weaknesses of each framework.

# Summary

## 1. Example used for the comparison:

*Display multiple Matplotlib figures and an animated sine wave*

## 2. Performance and Responsiveness:

*Streamlit can refresh figures at about 2 FPS, while Flatlight can update them at 35 FPS (it could be 120 FPS if using ImPlot instead of Matplotlib). However, no particular effort was made in optimizing streamlit workflow.*

## 3. Customization and Extensibility:

*Compare how each framework allows customization of widgets and extensibility.*

## 4. State Management:

*Evaluate how user inputs and application states are managed and restored.*

## 5. Algorithmic pipelines:

*Examine the support for chaining functions and visualizing their interactions.*

## 6. User Experience:

*Discuss the overall user experience, including UI manipulation capabilities.*

## 7. Ease of Use and Learning Curve:

*Assess the ease of learning and using each framework.*

## 8. Deployment and Accessibility:

*Compare the deployment capabilities and accessibility, including online execution.*

## 9. Community and Support:

*Look at the available community support and resources.*

## 10. Integration with Data Science Tools:

*Analyze how well each framework integrates with popular data science libraries and tools.*

# Detailed Comparison

## 1. Example used for the comparison

This comparison is based on the following example, which includes several Matplotlib figures, along with an animated sine wave.

### Using Fiatlight

See the code of [!\[\]\(5fe7faaa0891187c8cf892ba55a90e0f\_img.jpg\) figure\\_with\\_gui\\_demo.py](#).

Here it is in action with Fiatlight. The sine wave is animated at 35 FPS.

```
from fiatlight.fiat_kits.fiat_matplotlib import demo_matplotlib
figure_with_gui_demo.main()
```

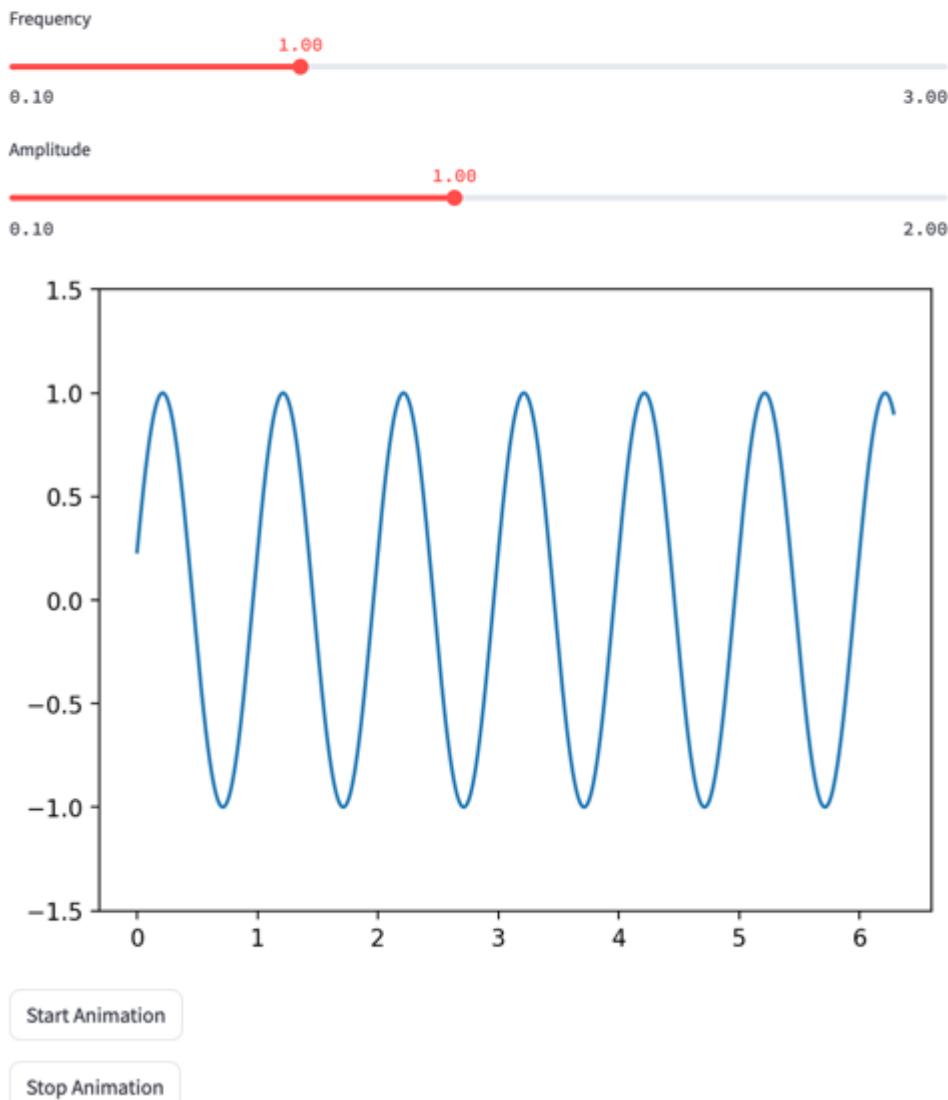
### Using Streamlit

The code for Streamlit was split into two parts: [!\[\]\(b1821d1949cb29f043abc0017902a4f0\_img.jpg\) figures](#) and [!\[\]\(6a44f5b15bcffbe908422a09ab9c52e1\_img.jpg\) animated sine wave](#).

Here are screenshots of it in action within Streamlit. The sine wave is animated at 2 FPS.

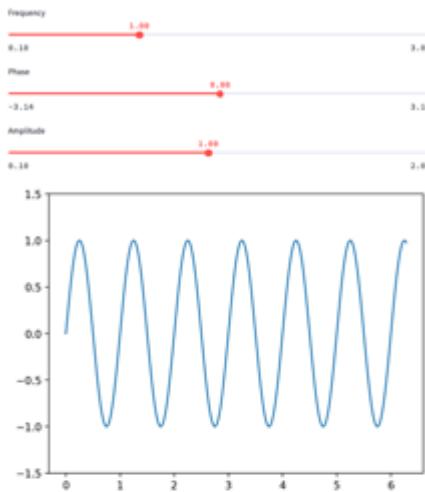
# Interactive Animated Sine Wave with Streamlit

## Interactive Sine Wave

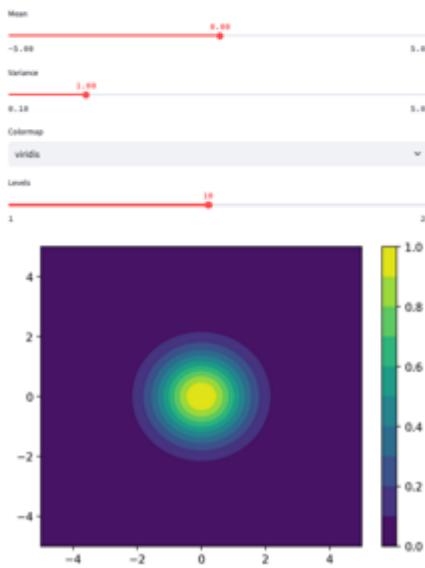


## Interactive Data Visualization with Streamlit

### Interactive Sine Wave



### Gaussian Heatmap



## 2. Performance and Responsiveness

- **Fiatlight:**
  - Updates at 35 frames per second, providing real-time interactivity. If using [ImPlot](#) instead of Matplotlib, Fiatlight would reach the artificial limit of 120 FPS.
- **Streamlit:**
  - Displays at about 2 frames per second. However, no particular effort was made in optimizing streamlit workflow; and better results may be possible (maybe by switching from Matplotlib to Plotly).

### 3. Customization and Extensibility

- **Fiatlight:**
  - Allows deep customization of widgets, including advanced editing types and ranges. Users can define custom widgets and function graphs for extensive flexibility.
- **Streamlit:**
  - Provides a wide range of built-in widgets and customization options, but may not match Fiatlight's specialized functionalities.

### 4. State Management

- **Fiatlight:**
  - Automatically saves and restores user inputs, widget placements, and settings. Supports saving different configurations and restoring them later.
- **Streamlit:**
  - Requires manual handling of state management. Users need to implement custom solutions to save and restore states across sessions.

### 5. Algorithmic pipelines

- **Fiatlight:**
  - Supports function graphs, enabling chaining of functions and visualization of their inputs and outputs, simplifying complex workflows.
- **Streamlit:**
  - Does not natively support function graphs. Users need to manually code function linkages, which can be more cumbersome.

### 6. User Experience

- **Fiatlight:**
  - Offers rich user experience with the ability to resize and move figures, enhancing usability and flexibility.
- **Streamlit:**

- Provides a straightforward interface but lacks advanced UI manipulation features like resizing and moving figures.

## 7. Ease of Use and Learning Curve

- **Fiatlight:**
  - Powerful and flexible but might have a steeper learning curve due to advanced features.
- **Streamlit:**
  - User-friendly and easy to learn, allowing rapid development and prototyping with minimal code.

## 8. Deployment and Accessibility

- **Fiatlight:**
  - Fiatlight can run inside a Jupyter Notebook, but requires a local environment and lacks web-based deployment capabilities. Efforts with pyodide are underway but still in development.
- **Streamlit:**
  - Easily deployable on the web and compatible with platforms like Google Colab, making it accessible from anywhere, which is advantageous for collaboration and sharing.

## 9. Community and Support

- **Fiatlight:**
  - May not have as extensive a community or support resources as Streamlit.
- **Streamlit:**
  - Large and active community, extensive documentation, and support resources, beneficial for new users and those seeking help or examples.

## 10. Integration with Data Science Tools

- **Fiatlight:**
  - Can integrate with data science tools but may require more setup and configuration. Its use of Dear ImGui allows for high-performance graphics and interactive applications,

which can be beneficial for certain data science applications.

- **Streamlit:**

- Well-integrated with popular data science libraries and tools, making it a go-to choice for data scientists and analysts.

## Conclusion

Both Fiatlight and Streamlit have their unique advantages.

- **Fiatlight** excels in high-performance applications, offering extensive customization, advanced interactive features, and sophisticated state management that includes automatic saving and restoring of user inputs and widget placements. This makes it exceptionally well-suited for rapid prototyping, as users can quickly iterate on their designs without losing their configurations. Its support for function graphs simplifies complex workflows, making it a powerful tool for developing intricate applications.
- **Streamlit** is ideal for users who prioritize ease of use and web-based deployment. It offers a user-friendly interface that facilitates rapid development and prototyping, especially for data-driven applications and dashboards. Its seamless integration with popular data science libraries and web deployment capabilities makes it accessible from anywhere, promoting collaboration and sharing.

The choice between them depends on the specific needs and preferences of the user or project. Fiatlight offers a more feature-rich environment for those needing advanced GUI capabilities and state management, while Streamlit provides a simpler, more accessible solution for data visualization and web deployment.

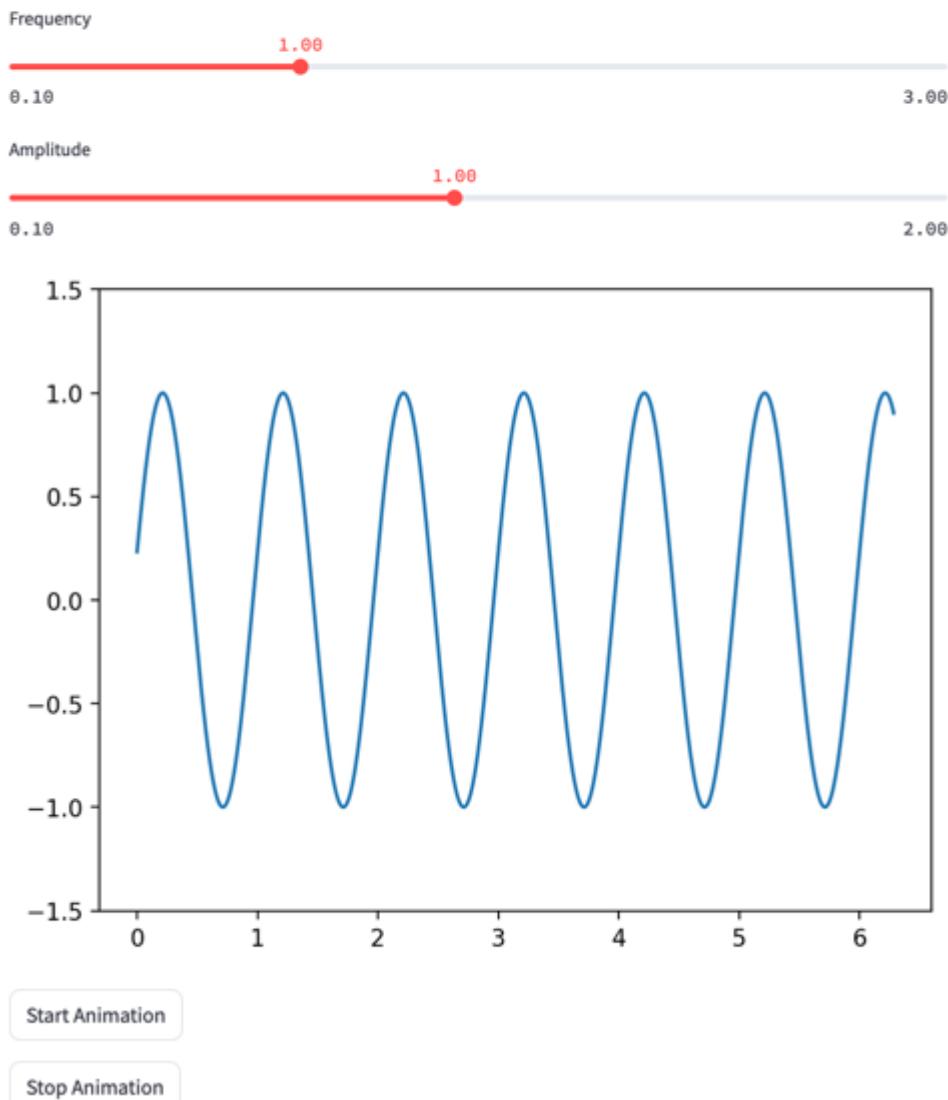
## Using Streamlit

The code for Streamlit was split into two parts: [figures](#) and [animated sine wave](#).

Here are screenshots of it in action within Streamlit. The sine wave is animated at 2 FPS.

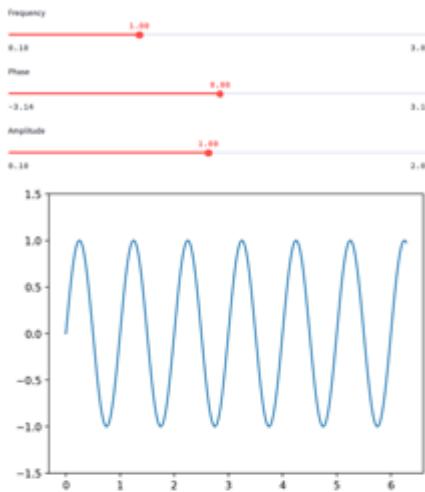
# Interactive Animated Sine Wave with Streamlit

## Interactive Sine Wave

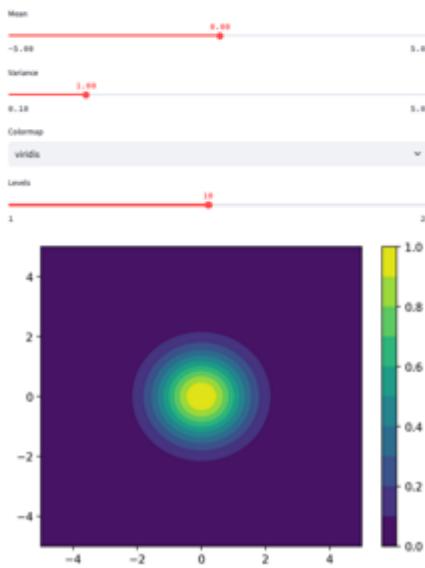


## Interactive Data Visualization with Streamlit

### Interactive Sine Wave



### Gaussian Heatmap



## 2. Performance and Responsiveness

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  - Fiatlight can run inside a Jupyter Notebook, but requires a local environment and lacks web-based deployment capabilities. Efforts with pyodide are underway but still in development.
- **Streamlit:**
  - Easily deployable on the web and compatible with platforms like Google Colab, making it accessible from anywhere, which is advantageous for collaboration and sharing.

## 9. Community and Support

- **Fiatlight:**
  - May not have as extensive a community or support resources as Streamlit.
- **Streamlit:**
  - Large and active community, extensive documentation, and support resources, beneficial for new users and those seeking help or examples.

## 10. Integration with Data Science Tools

- **Fiatlight:**
  - Can integrate with data science tools but may require more setup and configuration. Its use of Dear ImGui allows for high-performance graphics and interactive applications,

which can be beneficial for certain data science applications.

- **Streamlit:**

- Well-integrated with popular data science libraries and tools, making it a go-to choice for data scientists and analysts.

## Conclusion

Both Fiatlight and Streamlit have their unique advantages.

- **Fiatlight** excels in high-performance applications, offering extensive customization, advanced interactive features, and sophisticated state management that includes automatic saving and restoring of user inputs and widget placements. This makes it exceptionally well-suited for rapid prototyping, as users can quickly iterate on their designs without losing their configurations. Its support for function graphs simplifies complex workflows, making it a powerful tool for developing intricate applications.
- **Streamlit** is ideal for users who prioritize ease of use and web-based deployment. It offers a user-friendly interface that facilitates rapid development and prototyping, especially for data-driven applications and dashboards. Its seamless integration with popular data science libraries and web deployment capabilities makes it accessible from anywhere, promoting collaboration and sharing.

The choice between them depends on the specific needs and preferences of the user or project. Fiatlight offers a more feature-rich environment for those needing advanced GUI capabilities and state management, while Streamlit provides a simpler, more accessible solution for data visualization and web deployment.

## Comparison with Dash

This page provides a detailed comparison between Fiatlight and Dash, highlighting the strengths and weaknesses of each framework.

## Summary

1. **Example used for the comparison:** *Display multiple Matplotlib figures and an animated sine wave*

2. **Performance and Responsiveness:** *Dash can update the graph up to 45 FPS on a local server (using Plotly), but is likely to be slower on a remote server. Fiatlight can update the graph up to 35 FPS when using Matplotlib. If using [ImPlot](#) instead of Matplotlib, Fiatlight would reach the artificial limit of 120 FPS.*
3. **Customization, Layout and Extensibility:** *Compare how each framework allows customization of widgets and extensibility.*
4. **State Management:** *Evaluate how user inputs and application states are managed and restored.*
5. **Algorithmic Pipelines:** *Examine the support for chaining functions and visualizing their interactions.*
6. **User Experience:** *Discuss the overall user experience, including UI manipulation capabilities.*
7. **Ease of Use and Learning Curve:** *Assess the ease of learning and using each framework.*
8. **Deployment and Accessibility:** *Compare the deployment capabilities and accessibility, including online execution.*
9. **Community and Support:** *Look at the available community support and resources.*
10. **Integration with Data Science Tools:** *Analyze how well each framework integrates with popular data science libraries and tools.*

## Detailed Comparison

### 1. Example used for the comparison

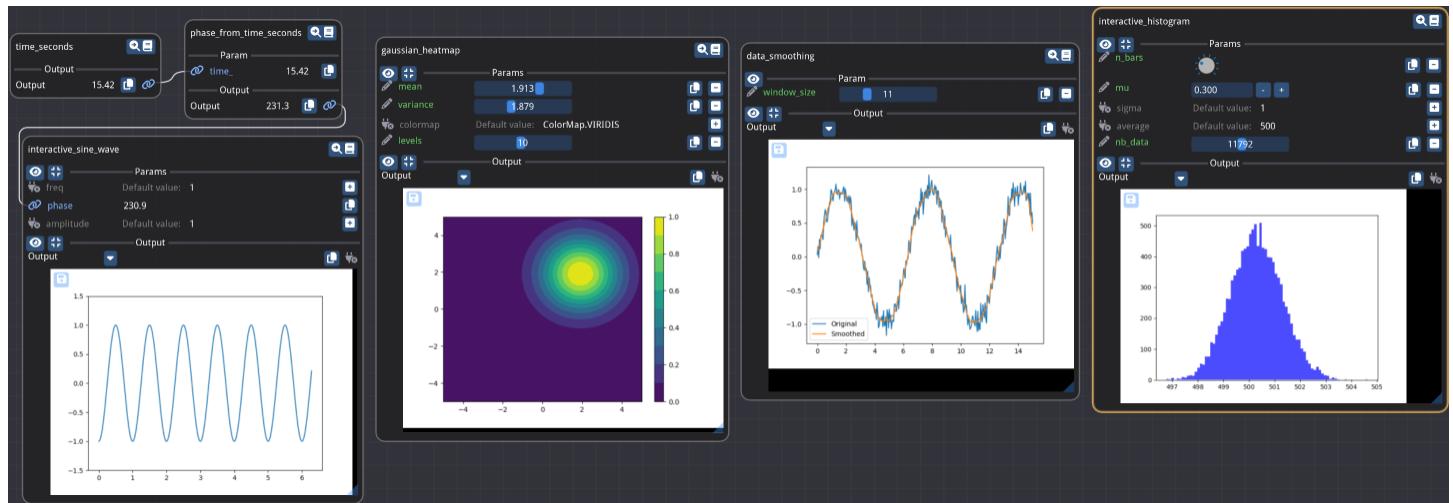
This comparison is based on the following example, which includes several Matplotlib figures, along with an animated sine wave.

#### Using Fiatlight

See the code of [!\[\]\(47e27a1b50a3199e512a5dd4ce3ee69f\_img.jpg\) `figure\_with\_gui\_demo.py`](#).

Here it is in action with Fiatlight. The sine wave is animated at 35 FPS (it could be 120 FPS if using ImPlot instead of Matplotlib).

```
from fiatlight.fiat_kits.fiat_matplotlib import demo_matplotlib  
figure_with_gui_demo.main()
```



## Using Dash

A similar application was coded for Dash. Here is its [source code](#).

And below is a screenshot of the Dash app with multiple figures and an animated sine wave.

### Interactive Plots with Dash



## 2. Performance and Responsiveness

- **Fiatlight:**

- When using Matplotlib, Fiatlight runs at 35 FPS. When using ImPlot, it runs at the artificial limit of 120 FPS.

- **Dash:**

- Dash can update the graph up to 45 FPS on a local server (using Plotly), but is likely to be slower on a remote server, because each timer update requires communication via a web socket.

### 3. Customization, Layout and Extensibility

- **Fiatlight:**
  - Allows deep customization of widgets, including advanced editing types and ranges. Users can define custom widgets and function graphs for extensive flexibility.
  - Supports advanced layout management, including resizing and moving figures. Arranging the functions on the screen is as easy as dragging with the mouse. And since those options are saved, they become part of the final application.
  - The code for the application occupies 135 Python lines.
- **Dash:**
  - Offers a wide range of customizable components including Knobs, but may require more manual coding to achieve highly customized interfaces.
  - The layout is achieved via standard HTML divs. Changing their size or moving them requires some adaptation on the Python side.
  - The code for the application occupies 242 Python lines.

### 4. State Management

- **Fiatlight:**
  - Automatically saves and restores user inputs, widget placements, and settings. Supports saving different configurations and restoring them later.
- **Dash:**
  - State management is manual and typically involves more code to save and restore states across sessions.

### 5. Algorithmic Pipelines

- **Fiatlight:**
  - Supports function graphs, enabling chaining of functions and visualization of their inputs and outputs, simplifying complex workflows.
- **Dash:**
  - Supports callbacks to chain functions but may be less visual and more code-intensive.

## 6. User Experience

- **Fiatlight:**
  - Offers a rich user experience with the ability to resize and move figures, enhancing usability and flexibility.
- **Dash:**
  - Provides a straightforward interface with interactive components but lacks advanced UI manipulation features like resizing and moving figures.

## 7. Ease of Use and Learning Curve

- **Fiatlight:**
  - Powerful and flexible, but it might require some initial learning since it is a novel framework. However, the immediate GUI mode is easy to grasp, making it accessible for new users.
- **Dash:**
  - User-friendly but can become complex with advanced use cases, requiring a good understanding of the Dash framework and callbacks.

## 8. Deployment and Accessibility

- **Fiatlight:**
  - Fiatlight can run inside a Jupyter Notebook, but requires a local environment and lacks web-based deployment capabilities. Efforts with pyodide are underway but still in development.
- **Dash:**
  - Easily deployable on the web, with built-in support for deploying to cloud platforms like Heroku and Azure.

## 9. Community and Support

- **Fiatlight:**
  - May not have as extensive a community or support resources as Dash.

- **Dash:**
  - Large and active community, extensive documentation, and support resources, beneficial for new users and those seeking help or examples.

## 10. Integration with Data Science Tools

- **Fiatlight:**
  - Can integrate with data science tools but may require more setup and configuration. Its use of Dear ImGui allows for high-performance graphics and interactive applications, which can be beneficial for certain data science applications.
- **Dash:**
  - Well-integrated with popular data science libraries and tools, making it a go-to choice for data scientists and analysts.

## Conclusion

Both Fiatlight and Dash have their unique advantages.

- **Fiatlight** excels in high-performance applications, offering extensive customization, advanced interactive features, and sophisticated state management that includes automatic saving and restoring of user inputs and widget placements. This makes it exceptionally well-suited for rapid prototyping, as users can quickly iterate on their designs without losing their configurations. Its support for function graphs simplifies complex workflows, making it a powerful tool for developing creative applications.
- **Dash** is ideal for users who prioritize building interactive dashboards and data visualization applications with ease of deployment. It offers a user-friendly interface that facilitates rapid development and deployment, especially for data-driven applications. Its seamless integration with popular data science libraries and robust web deployment capabilities make it accessible and powerful for building analytical web applications.

The choice between them depends on the specific needs and preferences of the user or project. Fiatlight offers a more feature-rich environment for those needing advanced GUI capabilities and state management, while Dash provides a robust solution for building and deploying data-driven dashboards and applications.

# Comparison with Jupyter Lab and ipywidgets

This page provides a detailed comparison between Flatlight and Jupyter Lab + ipywidgets, highlighting the strengths and weaknesses of each framework.

## Summary

1. **Example used for the comparison:** *Display multiple Matplotlib figures and an animated sine wave*
2. **Performance and Responsiveness:** *Compare the performances of both frameworks on live and static figures.*
3. **Customization, Layout and Extensibility:** *Compare how each framework allows customization of widgets and extensibility.*
4. **State Management:** *Evaluate how user inputs and application states are managed and restored.*
5. **Algorithmic Pipelines:** *Examine the support for chaining functions and visualizing their interactions.*
6. **User Experience:** *Discuss the overall user experience, including UI manipulation capabilities.*
7. **Ease of Use and Learning Curve:** *Assess the ease of learning and using each framework.*
8. **Deployment and Accessibility:** *Compare the deployment capabilities and accessibility, including online execution.*
9. **Community and Support:** *Look at the available community support and resources.*
10. **Integration with Data Science Tools:** *Analyze how well each framework integrates with popular data science libraries and tools.*

## Detailed Comparison

### 1. Example used for the comparison

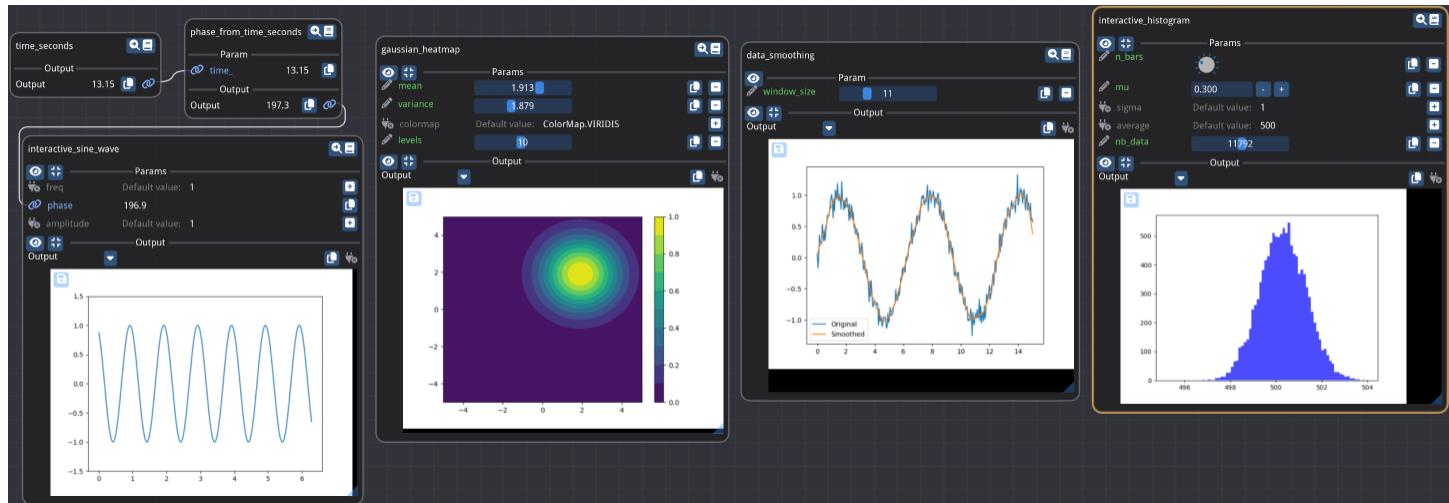
This comparison is based on the following example, which includes several Matplotlib figures, along with an animated sine wave.

## Using Fiatlight

See the code of [figure\\_with\\_gui\\_demo.py](#).

Here it is in action with Fiatlight. The sine wave is animated at 35 FPS (it could be 120 FPS if using ImPlot instead of Matplotlib).

```
from fiatlight.fiat_kits.fiat_matplotlib import demo_matplotlib
figure_with_gui_demo.main()
```



## Using ipywidgets / Jupyter Lab

A similar demo was created using Jupyter Lab and ipywidgets. It is available [in this notebook](#).

## 2. Performance and Responsiveness

It is surprisingly difficult to create live figures in Jupyter Lab. Also, while a figure is being updated, widgets will not transmit new values to python.

An animated figure can be created by updating a figure in a loop inside a cell. The refresh rate using Matplotlib is about 1 FPS, and much higher when using [ProgressPlot](#). However, the user has to wait until the cell has finished executing.

Fiatlight can update the graph up to 35 FPS when using Matplotlib. If using [ImPlot](#) instead of Matplotlib, Fiatlight would reach the artificial limit of 120 FPS. The updates are done asynchronously and all the other widgets remain active.

### 3. Customization, Layout and Extensibility

- **Fiatlight:**

- Allows deep customization of widgets, including advanced editing types and ranges. Users can define custom widgets and function graphs for extensive flexibility.
- Supports advanced layout management, including resizing and moving figures. Arranging the functions on the screen is as easy as dragging with the mouse. Since these options are saved, they become part of the final application.
- The code for the application occupies 135 Python lines.

- **Jupyter / ipywidgets:**

- Offers a variety of customizable components, including sliders, checkboxes, dropdowns, and text inputs. Users can create interactive widgets that integrate seamlessly with Jupyter notebooks.
- The layout is limited to what is possible inside a notebook, but you can use [ipywidgets](#)'s `HBox`, `VBox`, and other layout widgets to organize components. However, it lacks the advanced layout management features like resizing and moving figures within the notebook interface.
- The code for the application occupies 142 Python lines.

### 4. State Management

- **Fiatlight:**

- Automatically saves and restores user inputs, widget placements, and settings. Supports saving different configurations and restoring them later.

- **Jupyter / ipywidgets:**

- State management is manual and typically involves more code to save and restore states across sessions.

### 5. Algorithmic Pipelines

- **Fiatlight:**
  - Supports function graphs, enabling chaining of functions and visualization of their inputs and outputs, simplifying complex workflows.
- **Jupyter / ipywidgets:**
  - Supports sequential and interactive cell execution but lacks a native function graph feature. While users can manually code function linkages and interactions, it does not offer the same visual pipeline management as Fiatlight.

## 6. User Experience

- **Fiatlight:**
  - Offers a rich user experience with the ability to resize and move figures, enhancing usability and flexibility.
- **Jupyter / ipywidgets:**
  - offers a basic user experience for the final user. Note: the appearance of the ipywidgets is not restored when reopening a notebook: the user has to re-run the cells to get the widgets back.

## 7. Ease of Use and Learning Curve

- **Fiatlight:**
  - Powerful and flexible, but it might require some initial learning since it is a novel framework. However, the immediate GUI mode is easy to grasp, making it accessible for new users.
- **Jupyter / ipywidgets:**
  - offers a truly great experience for the developer, in terms of ease and speed of development.

## 8. Deployment and Accessibility

- **Fiatlight:**
  - Fiatlight can run inside a Jupyter Notebook, but requires a local environment and lacks web-based deployment capabilities. Efforts with pyodide are underway but still in development.

- **Jupyter / ipywidgets:**
  - deployable locally and on almost any cloud provider (Google Colab, Binder, etc.)

## 9. Community and Support

- **Fiatlight:**
  - May not have as extensive a community or support resources as more established frameworks, but it benefits from the communities of the libraries it builds upon, like Dear ImGui, Hello ImGui, and ImGui Bundle.
- **Jupyter / ipywidgets:**
  - Large and active community, extensive documentation, and support resources, beneficial for new users and those seeking help or examples. Many resources are available for troubleshooting and expanding functionality.

## 10. Integration with Data Science Tools

- **Fiatlight:**
  - Can integrate with data science tools but may require more setup and configuration. Its use of Dear ImGui allows for high-performance graphics and interactive applications, which can be beneficial for certain data science applications.
- **Jupyter / ipywidgets:**
  - Very mature integration with popular data science libraries and tools such as NumPy, pandas, scikit-learn, and more. It is widely used in the data science community, making it a go-to choice for data-driven research and analysis.

## Conclusion

Both Fiatlight and Jupyter Lab with ipywidgets have their unique advantages.

- **Fiatlight** excels in high-performance applications, offering extensive customization, advanced interactive features, and sophisticated state management that includes automatic saving and restoring of user inputs and widget placements. This makes it exceptionally well-suited for rapid prototyping, as users can quickly iterate on their designs without losing their configurations. Its support for function graphs simplifies complex workflows, making it a powerful tool for developing creative applications.

- **Jupyter Lab with ipywidgets** is ideal for users who prioritize ease of use, rapid development, and integration with data science tools. It offers a user-friendly interface that facilitates interactive data analysis and visualization. The extensive community support, along with its deployment capabilities on platforms like Google Colab and Binder, make it highly accessible and powerful for educational and research purposes.

The choice between them depends on the specific needs and preferences of the user or project. Flatlight offers a more feature-rich environment for those needing advanced GUI capabilities and state management, while Jupyter Lab with ipywidgets provides a robust solution for interactive data science and educational applications.

## The Rosetta Challenge

### Challenge description

The example below is more contrived, but it will be used as a basis to compare Flatlight with other frameworks and languages, in terms of code, clarity and conciseness.

Suppose we have been given the instructions below. Our goal is to create the most concise and understandable code that follows these instructions.

Given the function below, which includes hints for the graphical user interface developer as well as documentation for the final user, write a program that implements a GUI for this function.

#### Parameters input

- The age should be entered via a slider. It should take into account the hints given in the user documentation.
- The name should be entered via a text input. It should occupy one line only. A placeholder "your name..." should be displayed when it is empty.

#### Output

- The program should display the function result as a string. It should be displayed in a text box or label

## User documentation

- The documentation inside the function below is a user facing doc and should be displayed in an optional tooltip or dialog box that can be opened from the function.
- Bonus points: display the doc with a nice renderer such as a markdown renderer (for example)

## Code of the function for which a GUI is to be created

Below is an implementation of the Rosetta code in Python. It could be in any language, actually.

```

def hello_rosetta(name: str, age: int) -> str:
    """hello_rosetta: A function that greets a person by name and age
    =====
    Args
    -----
    * `name` (str) : The name of the person.
    * `age` (int)  : The age of the person. Should be between 0 and 125
    Returns
    -----
    * `str`        : A greeting message, with a special welcome message for new
    * Rosetta is an old-fashioned lady, and can only understand non-accentuated
    * spaces, and "-". Her memory is failing, and she cannot remember more than 1
    * Her keyboard is broken, and she can only type one time the letter 'a' or 'A'
    Poor Rosetta!
    =====

    # Check input, Rosetta is intransigent
    letters_a = list(filter(lambda x: x == "a" or x == "A", name))
    if len(letters_a) > 1:
        return "My keyboard is broken, I can only type one time the letter 'a'"

    if len(name) == 0:
        raise ValueError("Please enter your name.")
    elif len(name) > 10:
        raise ValueError("My memory is failing, please enter a name with less t")
    elif not name.isalpha():
        raise ValueError("Hey, I'm an old-fashioned lady, I can only understand")
    elif not 0 <= age <= 125:
        raise ValueError("Sure you are not a ghost? Please enter an age between")

    if age == 0:
        return f"Hello, {name}, welcome to the world!"
    elif age == 1:
        return f"Hello, {name}, you are {age} year old."
    else:
        return f"Hello, {name}, you are {age} years old."

```

## Solution with fiatlight

Below is the implementation of the solution with Fiatlight: 23 lines, including empty lines and comments! It is even shorter than the specification.

```

import fiatlight as fl # noqa

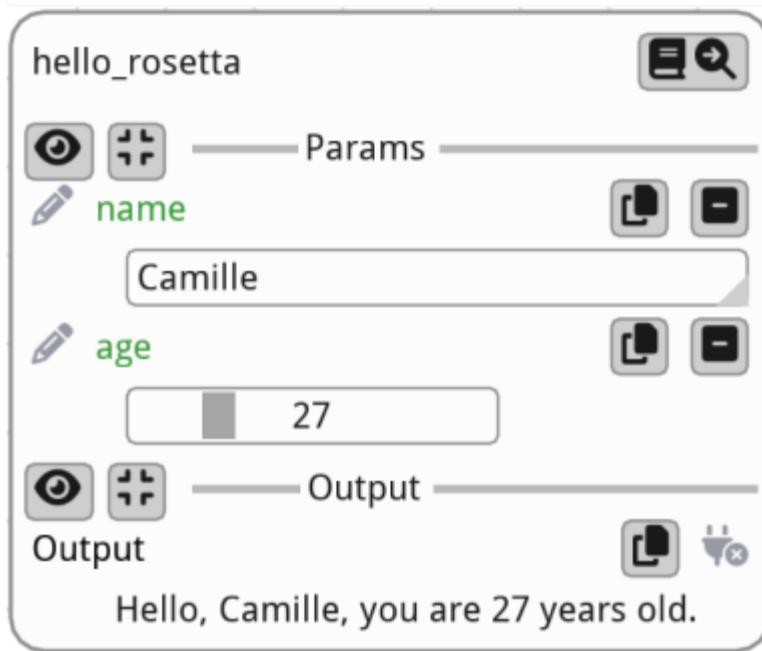
def validate_name(name: str) -> str:
    if len(name) == 0:
        raise ValueError("Please enter your name.")
    if len(name) > 10:
        raise ValueError("No more than 10 characters, please")
    if not name.isalpha():
        raise ValueError("Only non-accentuated latin letters are allowed")
    letters_a = list(filter(lambda x: x == "a" or x == "A", name))
    if len(letters_a) > 1:
        raise ValueError("Only one 'a' or 'A' is allowed")

    return name

fl.add_fiat_attributes(
    hello_rosetta,
    age_range=(0, 125),
    name_hint="Enter your name",
    name_validator=validate_name,
    doc_display=True,
)
fl.run(hello_rosetta, app_name="Rosetta Challenge")

```

2024-06-17 01:59:07.240 Python[40904:28949420] WARNING: Secure coding is not enabled



*Below is a video of this application*

0:00

